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# TECHNICAL REPORTS SECTION

## ABSCISSION AGENT EFFECTS ON SHAKER-CATCHFRAME HARVEST OF 'VALENCIA' ORANGE<sup>1</sup>

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### ABSTRACT

Four abscission agents (Acti-Aid, 20 ppm) (RELEASE, 250 ppm) (Acti-Aid, 5 ppm + Sweep, 250 ppm + Release, 150 ppm) and (Pik-Off, 300 ppm) were applied to the same orange trees (*Citrus sinensis* (L) Osbeck, cv 'Valencia') for 3 consecutive years to aid harvest with a shaker-catchframe system. This cultivar usually has both mature and immature fruit present at harvest; and this condition presents situations involving many interactions among chemicals, stages of growth (maturity), and mechanical shaking effects. The use of these abscission chemicals had little value in preventing subsequent reductions in fruit yield.

Early and midseason oranges can be successfully harvested mechanically with limb shakers without the use of abscission chemicals (1, 2, 5). Abscission agents expedite fruit removal; fruit can be removed in a shorter time with less energy expenditure and mechanical wear on the shaker (8). However, abscission agents do not increase the percent removal; the limb shaker operator can harvest almost 100% of the fruit

from citrus trees which have received no abscission agents, if he increases the shaking time. One reason for this is that citrus fruits are relatively heavy (avg 200 g) in contrast to a small fruit such as our cherries; so even immature fruit can be dislodged.

The late Valencia orange is very desirable for processing and makes up about 40% of orange production in Florida (3). Nearly 93% of 1978-79 Florida orange production from 231,000 ha was utilized for processing. The Valencia orange presents special mechanical harvesting problems, because the fruit reaches desirable processing maturity in late April to early July after the tree has bloomed and the young (next year's) crop has formed. During this period, many morphological and physiological changes occur with young fruit. A period of natural young fruit drop occurs following bloom and this diminishes to a low level near mid-May (2). Perhaps not coincidentally, a period of poor response of mature fruit to abscission agents usually occurs about mid-May (4). The interaction of these changes creates a difficult harvesting condition, because factors affecting the selective removal of mature vs. young fruit constantly change with time.

Coppock et al. (2) reported that Valencia could be harvested mechanically using no abscission agents until early May without large yield reductions, because the immature fruit had developed very little mass before this date. However, field experience has shown that, if mechanical removal systems are used, care has to be exercised to prevent removal or injury of the immature fruit after early May.

<sup>1</sup> Cooperative research by Florida Department of Citrus, University of Florida, and USDA, Science and Education Administration, Agricultural Research.

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Use of abscission agents should protect immature fruit by reducing the amount of force necessary to remove the mature fruit with shaker-type harvesting systems. Acti-Aid (cycloheximide or 3-[(R)-2-(1S, 3S, 5S)-3,5-dimethyl-2-oxocyclohexyl]-2-hydroxyethyl glutarimide), Pik-Off (ethanedial dioxime), Release (5-chloro-3-methyl-4-nitro-1H-pyrazole), a combination treatment of Release, Acti-Aid, and Sweep (chlorothalonil or tetrachloroisophthalonitrile) loosen mature Valencia fruit (9), only Acti-Aid has full U.S. government approval.

The purpose of this paper is to give the results of an experiment to evaluate the effect of several abscission agent treatments on the performance (as measured by subsequent yields) of a limb shaker-catchframe harvest system.

## MATERIALS AND METHODS

A 3-year experiment was initiated in a typical Valencia orange grove in the Ridge section (interior) of Florida. The grove was situated on slightly rolling terrain; rootstock was rough lemon; tree spacing was 7.6 m × 7.6 m (25 ft × 25 ft) and tree height ranged from 6 to 8 m (20 ft to 25 ft). In 1975, trees were hedged to a 2.1 m (7 ft) wide middle and undesired limbs pruned. This operation reduced average yield per tree from 408 kg (900 lb) in 1975 to 286 kg (610 lb) in 1976.

The experiment consisted of mechanically harvesting four abscission agent treatments which were compared with both unsprayed and handpicked controls (Table 1). Chemical effectiveness was measured by percent of mature fruit removed as well as effect on subsequent fruit yields. Tests were conducted near 1 May (test 1) and 1 June (Test 2), 1976, 1977, and 1978, using three-plots with three replications in a completely randomized block design. Test 1 was conducted each year when young fruit mass and fruit removal force (FRF) were relatively small and when young fruit drop was large. Test 2 was conducted when young fruit mass and FRF were rapidly increasing and immature fruit drop had diminished.

Thirty-eight liters (10 gal) of spray material were applied to each tree using a modified AgTec sprayer. Ortho X-77 surfactant was used with Acti-Aid, Release, and combinations of Acti-Aid, Sweep, and Release (ASR) at 0.6 ml per liter. As recommended by the manufacturer, no surfactant was used with Pik-Off (6). Plots were harvested 4 days following chemical application. One plot of nine adjacent trees was hand harvested near 1 June of each year to show seasonal yield variations.

Plots were harvested with a shaker-catchframe harvest system (1). Fruit lost over the catchframes and from preharvest drop was gleaned manually and were included in the total fruit recovered with the system. Fruit remaining on the trees were subsequently hand-harvested and weighed, and these totals were added to each plot for determination of yield and fruit recovery. FRF (9) was taken immediately before harvest, using 15 randomized fruit per plot. Preharvest drop was determined by averaging fruit dropped under the center tree of each three-tree plot.

To characterize the young fruit condition at harvest, the average mass, FRF, and cumulative droppage of young fruit were determined at 1 week intervals during the harvest season.

## RESULTS

The system performance data (3-year average) are given in Table 1. Seasonal FRF reductions from chemical treatments ranged from 41% for Acti-Aid treatment to 70% for ASR combination treatment. Seasonal pre-harvest fruit drop ranged from 1 to 36%, and fruit recovered from the system ranged from 90 to 98% for the treatments, with recovery being slightly less for the control. The composite curves of young fruit mass, FRF, and droppage in Fig. 1 show the relative status of immature fruit development when the tests were conducted.

The effects of chemical treatments on subsequent fruit yields were determined by comparing average initial yield for each plot with the average subsequent yields obtained from the treatments and that obtained from the hand-picked plots (Fig. 2). This is shown as the percent deviation (difference) between the initial and subsequent yields. The deviations for hand pick were +3%, +21% for 1976 and 1977 seasons, respectively, and +4% for 1978. The average for the 3 seasons was +6%. These deviations indicate the yield variations among years.

The average 3-year deviation of fruit yields (Fig. 2) indicates no significant differences among chemical treatments compared to the no-chemical control; however, the negative deviations for ASR combination and Pik-Off treatments in Test 2 and Acti-Aid in Test 1 were sufficiently large to indicate some differences may exist. Indeed, Acti-Aid treatments in Test 1 caused significant negative deviations from the no-chemical control for both 1976 and 1977. However, in 1978 a significantly positive deviation was obtained, and a significantly positive deviation of 41% was also obtained in Test 2 in 1977. The only other significant yield difference was a negative deviation by Pik-Off in Test 2 in 1977.

## DISCUSSION

Previous studies (8) show applications of Acti-Aid applied 6 to 8 weeks following bloom can adversely affect young fruit, but this effect is lessened if applied 10 to 14 weeks following bloom. This may explain some of the negative deviations obtained with Acti-Aid. Pik-Off caused no yield reduction in Test 1 but reduced yields in Test 2, although, again, this was not significant over the 3-year period. Pik-Off has been reported to reduce subsequent yields (7) if sprays are applied when young fruit average diameter is 2.5 cm (1 in) or greater (usually 12 to 16 weeks following bloom). It is possible that the yield reduction obtained in this test with Pik-Off was caused primarily by chemical effects.

Release treatments in both Tests 1 and 2 showed less yield variations than the other three chemical treatments. The effects of the ASR combination, however, are more difficult to assess. Although the fruit yields in Test 1 are virtually identical with those of Release, those in Test 2 show a slight, though not significant, yield reduction. However, the mixing of Acti-Aid with Release at the concentration used appeared to partially eliminate the yield reduction noted in Test 1 caused by Acti-Aid alone.

Yield patterns in the 1976 test indicated yield recutions were possible from the mechanical shaking time, although the amount of decrease following Release treatment (Test 2) was very slight (Fig. 2). In the 1977 and 1978 tests, however, most treatments appeared to have recovered; the Test 1 Acti-Aid treatment (1978), particularly, having improved very dramatically.

In conclusion, this study showed that the four chemical treatments did not materially aid the shaker-catchframe harvest system in the selective harvest of Valencia oranges. All chemical treatments loosened most of the mature fruit on the trees resulting in substantially lower FRF values as has been commonly observed (7); but evidently, to remove the remaining unloosened mature fruit, a shaking intensity was needed equivalent to that required where no chemicals had been used. The data strongly indicate that the mechanical harvest of Valencia oranges, with or without chemicals, after the beginning of May can be done in Florida, but probably only if the grower is willing to accept fruit reductions in some subsequent harvest seasons. However, over a period of time Valencia may be capable of adjusting to mechanical harvesting conditions by producing larger-than-average yields following 1 or more years of substantial fruit reduction. Only Pik-Off and Acti-Aid caused significant yield reductions due to chemical effect, and these occurred at different periods of

the Valencia harvest season. These data also confirm earlier findings that Pik-Off should not be used late in the Valencia season (6).

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Table 1. The 3-year average chemical and harvest system performance using four abscission chemical treatments and Valencia oranges.

Chemical Conc Treatments <sup>1</sup>	Harvest Date	FRF & SD <sup>2</sup> Newtons	Avg FRF % Reduction	Preharv. Drop Range, %	Fruit Recov. Range, %
Control (No chemical)	May 4-10	82.8 ± 18.7	0	0-0	95-97
	June 3-6	83.7 ± 8.7	0	0-0	92-93
Acti-Aid 20 ppm	May 4-10	41.4 ± 7.6	50	1-9	95-95
	June 3-6	49.0 ± 10.7	41	1-2	90-96
Release 250 ppm	May 4-10	28.5 ± 1.8	66	5-36	95-97
	June 3-6	27.1 ± 3.0	68	4-12	95-97
ASR Comb 2.5-250-150 ppm	May 4-10	25.8 ± 0.9	69	4-36	96-98
	June 3-6	25.4 ± 8.3	70	2-7	92-97
Pik-Off 300 ppm	May 4-10	40.9 ± 7.8	51	3-31	94-97
	June 3-6	36.0 ± 5.9	57	1-5	92-98

<sup>1</sup> Acti-Aid is cycloheximide; Release is 5-chloro-3-methyl-4-nitro-1H-pyrazole; Pik-Off is glyoxal dioxime; Sweep is chlorothalonil

<sup>2</sup> FRF — Fruit removal force (1.0 Newton = 0.225 ft lb)

<sup>3</sup> ASR — Acti-Aid + Sweep + Release

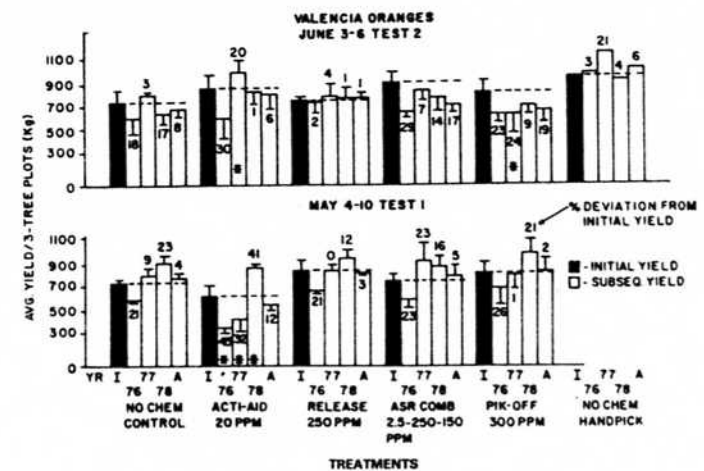
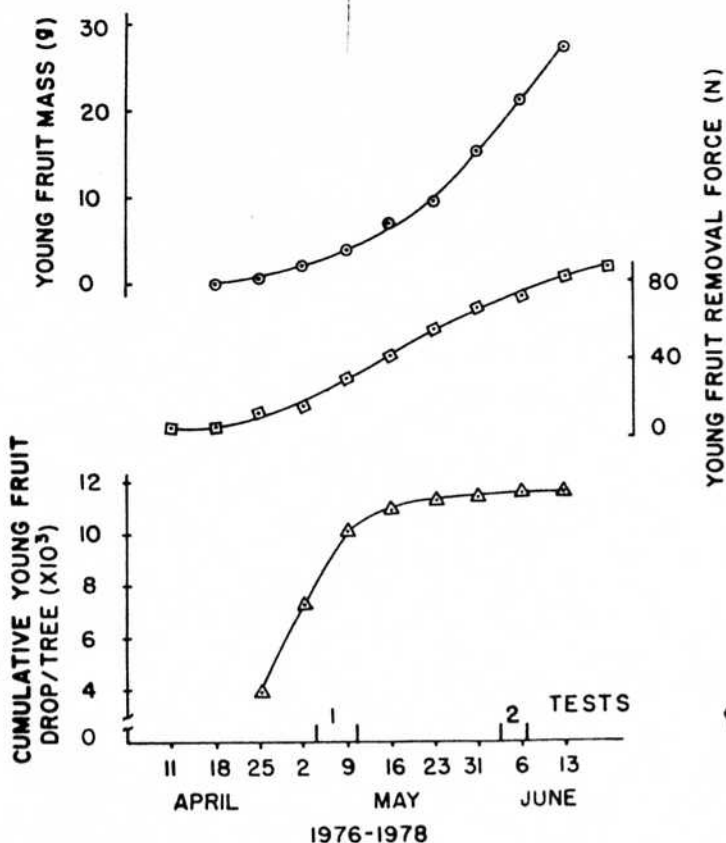


Fig. 2. The initial (1976) and subsequent plot yields from 1976, 1977, 1978 tests and 3-year avg (A) and the % deviation of subsequent from initial yields for 4 abscission chemical treatments, a no-chemical control and no-chemical handpick control. Standard deviation of individual yield populations is shown by a bar. Significant at 0.5 level is indicated by \*.

Fig. 1 Composite curves showing young fruit mass, removal force and droppage during the 1976, 1977 and 1978 harvest seasons. Test 1 was conducted during a period of large young fruit drop and Test 2 was conducted after the drop had diminished.