

ORANGE YIELD AND REMOVAL STUDIES WITH AIR AND TRUNK SHAKERS USING TWO ABSCISSION CHEMICALS

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Abstract. The abscission chemicals Release and Acti-Aid were applied to 'Queen' oranges during the bloom period and to 'Valencia' oranges at 3 stages of young fruit development. In 'Queen' oranges, air and trunk shakers averaged 98% and 92% mature fruit removal with Release and Acti-Aid, respectively; in 'Valencia' oranges, 86% and 74%. Subsequent fruit yields of 'Queen' orange trees were not significantly reduced by the use of either shaker or chemical. In 'Valencia' oranges, Acti-Aid significantly reduced subsequent yields when harvested at the early stages of young fruit development, whereas Release did not reduce yields at any stage on handpicked trees. The average effect of both shakers with Release reduced subsequent fruit yields 15%.

During past seasons and up until the 1975 'Valencia' season, fruit removal in mechanical harvesting systems used by Florida growers has been for the most part by air, trunk, and limb shakers with the fruit loosening assistance of the abscission chemical, Acti-Aid. Fruit removal with shakers during each season has been confined mainly to early and midseason oranges prior to the period of tree flush and bloom. During this period and through the 'Valencia' season, shaker concepts (with or without Acti-Aid) have not demonstrated an acceptable level of performance because of low percentage mature fruit removals and/or reductions in subsequent yields.

Tests on a new abscission chemical, Release (formerly ABG-3030), were reported in 1973 (4) and 1974 (1). It demonstrated little or no apparent damage to new growth, blooms, and young fruit while usually providing a significant amount of mature fruit loosening. During the 1975 'Valencia' season, an experimental use label was obtained from the EPA on Release for use on round oranges.

In this paper, fruit removal efficiencies and subsequent yields are reported on experiments of one year duration using the OMC trunk shaker and the AREC air shaker with Acti-Aid or Release. Similar reports have been made to this Society on air shakers and Acti-Aid (2,3) but not on trunk shakers or Release.

Methods and Materials

Figs. 1 and 2 show the AREC air shaker and the OMC trunk shaker used for mechanical fruit removal in the experiments. The air shaker was constructed in 1973 and consisted of 2 engines and 3 vane-axial fans with a total air moving capability of approximately 180,000 cfm. For fruit removal, the air shaker made 2 passes per tree, 1 on each side in the wide middle. The trunk shaker was OMC's latest 3-wheel model designed for citrus. Fruit removal was achieved by first clamping and shaking the tree trunk. If mature fruit removal was judged to be too low, additional clamping and shaking proceeded on the main lateral limbs.

A total of 5 tests were conducted with Tests 1 and 2 in 'Queen' oranges and Tests 3, 4, and 5 in 'Valencia' oranges. Each test included 28 trees with 7 treatments (Table 1) replicated 4 times on 1-tree plots. Treatments 1 through 6 were arranged in a split plot design with abscission chemicals (Release and Acti-Aid) as the main plots and removal methods (air, trunk, hand) as sub plots. Treatment 7 (handpick, no chemical)

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Fig. 1. AREC air shaker with 3 vane-axial fans (48 in.) and 2 engines.

was included between the main plots in each replication as a check on subsequent yields.

'Queen' Oranges Tests 1 and 2 were conducted in 2 'Queen' orange groves in early March during the bloom and flush period. Many of the trees in Test 1 had blossoms while those in Test 2 had pinhead blooms and/or young fruit up to



Fig. 2. Three-wheel, OMC trunk shaker designed for citrus.

Table 1. Treatments used in the Tests 1 through 5

| Treatment No. | Description ^z |
|---------------|-------------------------------------|
| 1 | Release ^y & air shaker |
| 2 | Release ^y & trunk shaker |
| 3 | Release ^y & handpick |
| 4 | 20 ppm Acti-Aid & air shaker |
| 5 | 20 ppm Acti-Aid & trunk shaker |
| 6 | 20 ppm Acti-Aid and handpick |
| 7 | No chemical & handpick |

^z Chemicals applied in 6 and 15 gal water/tree in 'Queen' and 'Valencia', respectively. Ortho X77 surfactant used at 2.4 ml/gal water with Release and Acti-Aid in Tests 1-3. Component B (Upjohn) used with Acti-Aid in Tests 4 & 5 at 7 ml/gal water. Chemical rates per acre-- Tests 1 & 2, 1.2 units Acti-Aid, 2.4 units Release; Tests 3, 4, 5, 2 units Acti-Aid, 5 units Release.

^y 200 ppm in 'Queen' (Tests 1 & 2); 250 ppm in 'Valencia' (Tests 3-5).

1/4 inch diameter. The trees were set 30 x 15 ft and ranged in height from 8 to 15 ft. The abscission chemicals (see Table 1 for rates) were applied on February 28 and March 1, 1974, in the Tests 1 and 2, respectively, and the fruit was harvested 4 days after spraying. The air shaker was operated at 1 mph ground speed with only the 2 bottom fans discharging air. With the trunk shaker, only 1 clamp per tree was necessary. Fruit yields, percentage preharvest mature fruit drop and removal were recorded in 1974. In 1975, fruit yields were obtained for Test 2 only because the fruit in Test 1 was inadvertently harvested before the yields were recorded.

'Valencia' Oranges Tests 3, 4, and 5 were 3 dates of harvests (April 22, May 15, and June 5) in 1974 when the young fruit averaged 0.4 cm, 1.0 cm, and 2.6 cm in diameter. In each test, Release and Acti-Aid (see Table 1 for rates) were applied 5 days before harvest. The trees were 15 to 22 ft high and spaced 25 x 25 ft. The air shaker operated at 1 mph ground speed with all 3 fans discharging air. With the trunk shaker, more than 1 clamp per tree was often necessary. In 1974, preharvest mature fruit drop, young and mature fruit removal, and yields of mature fruit were recorded. Only mature fruit yields were recorded in 1975.

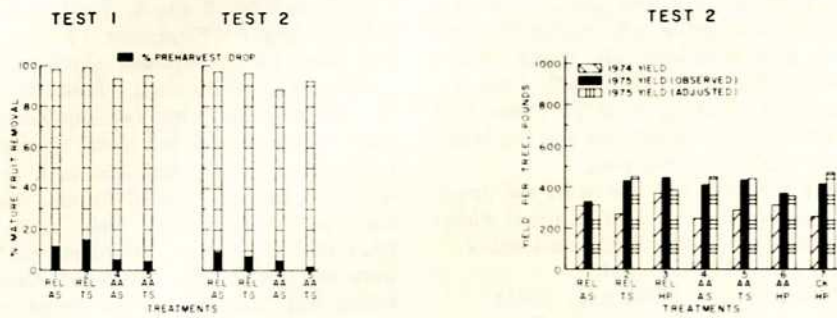
Results and Discussion

'Queen' Oranges Results on preharvest fruit drop and fruit removal by the shakers are depicted in bar graphs in the upper left hand corner of Fig. 3. Based on these two attributes, Release

FRUIT REMOVAL, 1974

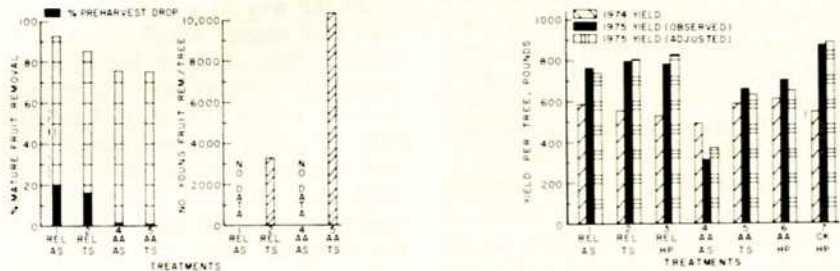
FRUIT YIELD, 1974 & 1975

QUEEN ORANGES

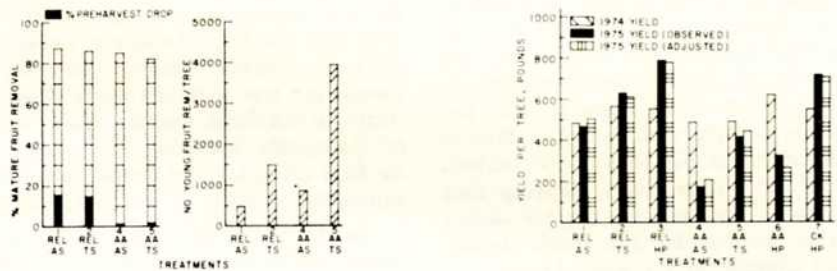


VALENCIA ORANGES

TEST 3 APRIL 22 - YOUNG FRUIT - 0.4 CM DIA.



TEST 4 MAY 15 - YOUNG FRUIT - 1 CM DIA.



TEST 5 JUNE 5 - YOUNG FRUIT - 2.6 CM DIA.

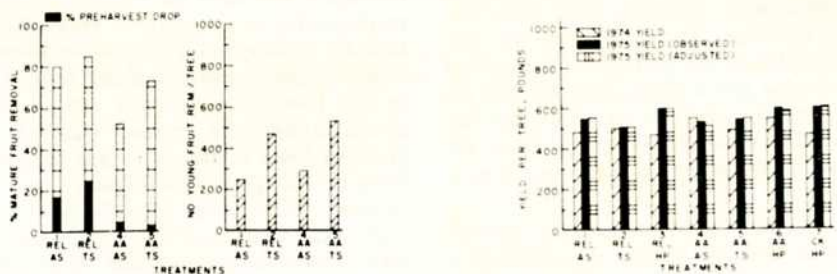


Fig. 3. Fruit removal and yield data for 'Queen' oranges (Tests 1 & 2) and 'Valencia' oranges (Tests 3, 4 & 5). REL = Release; TS = Trunk Shaker; AA = Acti-Aid.

provided superior fruit loosening to Acti-Aid at the rates used. Preharvest fruit drop averaged 6% higher with Release. Average percentage fruit removal with both shakers was also 6% higher with Release and defoliation was noticeably less. Averaged over both chemicals, the trunk shaker and air shaker achieved 95 and 94% fruit removal, respectively. Shaking time per tree (not shown) averaged 12 and 20 seconds for the trunk shaker and air shaker, respectively.

Yield data for Test 2 are shown in the upper right hand corner of Fig. 3. The adjusted yields for 1975 were calculated using Equation 1 below.

$$1975 \text{ adj yield} = 1975 \text{ obs. yield} \\ + b (1974 \text{ obs. yield} - 1974 \text{ avg. yield})$$

Equation 1

Equation 1 is a regression equation and simply adjusted the 1975 observed yields in a linear manner based on the assumption that the 1974 observed yields were indicative of the 1975 yielding potential of the trees. Coefficient b, the error regression coefficient, was determined from a covariance analysis of the 1974 and 1975 observed data with the 1974 data as the independent variable. Coefficient b was -0.81 for Test 2.

An analysis of variance of the 1975 adjusted yield data showed that there were no statistical differences (0.05 level) among treatment means.

Valencia Oranges As with Tests 1 and 2, Release provided significantly better mature fruit loosening in Tests 3, 4, and 5 than Acti-Aid at the rates used. Release resulted in an average of 18% preharvest mature fruit drop vs 2% for Acti-Aid (see Fig. 3). The shakers achieved an average of 86% mature fruit removal with Release as compared to 74% with Acti-Aid. Mature fruit removals with the air and trunk shakers averaged 79 and 81%, respectively. Shaking time per tree averaged 34 seconds for the air shaker (1 mph) and 20 seconds for the trunk shaker, which made an average of 2.1 clamps/tree.

Young fruit removal by the shakers was 2 to 3 times higher with Acti-Aid than with Release in all 'Valencia' Tests. Because of the difficulty of containing the young fruit removed in the high velocity air stream, data on the air shaker were not as accurate as those on the trunk shaker. The number of young fruit removed per tree decreased with increasing young fruit diameter.

The 1975 adjusted yield data show several significant results with the values of coefficient b (Equation 1) in Tests 3, 4, and 5 being -0.95 , -0.65 , and -0.16 , respectively. Release did not

reduce yields (Treatment 3 vs 7) at any stage of young fruit development, whereas Acti-Aid significantly (0.05 level) reduced yields (Treatment 6 vs 7) in Tests 3 and 4. Yields for Release with the air shaker (Treatment 1) were significantly less than the handpicked check only in Test 4 (young fruit -1.0 cm). Yields for Release with the trunk shaker were not significantly less than those of the handpicked check in any of the tests. In Tests 3 and 4, Acti-Aid with the air shaker caused substantial yield losses, while Acti-Aid with the trunk shaker yield losses were somewhat less. Treatment differences in Test 5 yields were not statistically significant. One datum point which did not follow the trend of the other data was that the yield associated with Treatment 6 was lower than that of Treatment 5 in Test 4. No explanation was apparent.

In the way of general discussion, trees in all tests had several bloom sets and were probably characteristic of most Ridge Area citrus trees which had been exposed to warmer-than-normal dormant periods. Chemical defoliation (especially with Acti-Aid) of the 'Queen' trees in Test 1 was considerably more than in Test 2 and 1975 yield data for Test 1, had they been obtained, might have shown more adverse yield effects of the chemicals than were indicated in Test 2.

Mature fruit loosening by the abscission chemicals was not uniform in the 'Valencia' Tests. Release caused an average of 18% preharvest drop but did not adequately loosen 14% of the fruit for shaker removal. The average of 2.1 clamps per tree with the trunk shaker was an attempt to maximize mature fruit removal because of inadequate loosening. This was accomplished by first clamping the trunk followed by 1 to 3 subsequent clamps on the main lateral limbs.

In the 'Valencia' tests, the average 1975 adjusted yields for the handpicked check trees was 734 lbs/tree. Adjusted yields for Treatments 1 through 6 averaged 82, 87, 101, 50, 74, and 69%, respectively, of this figure. This indicated overall that for subsequent yields to be preserved at the handpick check level, shaking energy transmitted to the tree by either the air or trunk shaker should probably be reduced below the levels used in these tests if the trees are sprayed with Release at 250 ppm. Handpicked trees which were sprayed with Release suffered no subsequent yield loss. With Acti-Aid at 20 ppm, subsequent yield losses were significant when averaged over the harvest season, regardless of the method of fruit removal.

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