Reprinted from Volume 81 of the Proceedings of the
FLORIDA STATE HORTICULTURAL SOCIETY
Miami, November 5-8, 1968

CHEMICAL ABSCISSION STUDIES OF ORANGES AND TRIALS WITH MECHANICAL HARVESTERS[1, 2]

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ABSTRACT

Chemicals used in field abscission trials fall into 2 general categories: "hormone level" chemicals and "mass action" chemicals. Only the latter class of chemicals was effective in producing abscission this year, which is in contrast to findings in previous years. Ascorbic and erythorbic acids, alone or in combination with citric acid, were effective in producing abscission on all citrus varieties tested. One promising new chemical and one promising additive for ascorbic acid were found to be effective. The "mass action" type chemicals may offer promise for a practical approach to abscission in Florida.

Chemical abscission increases the efficiency of mechanical shakers, and effectively loosened 'Valencia' oranges for mechanical shaker tests. However, there was some excess droppage of green fruit following chemical treatment and mechanical shaking.

Florida Agricultural Experiment Stations Journal Series No. 3107.

[1]Cooperative research of the Florida Citrus Commission and Florida Citrus Experiment Station.

[2]Acknowledgment is hereby given to Chas. Pfizer & Co., Hoffmann-La Roche, Inc., Abbott Laboratories, AmChem Products, Inc., International Minerals & Chemical Corp., and others for supplies of experimental chemicals.

INTRODUCTION

Chemical abscission agents could aid mechanical harvesting of fruits, and increasing amounts of money and manpower have been assigned to this project in recent years. Tests with mechanical harvesters have shown that, although the per cent of fruit removed is not increased by use of an abscission chemical, the overall efficiency of the inertia shaker (trees harvested per hour) can be increased 20 to 30%. This relatively low percentage increase is because this type shaker has fixed operations such as clamping and unclamping limbs, moving, extending and retracting the catchframes, etc., which are not affected by abscission sprays. The FMC Corporation Air Shaker Harvest System, however, has few fixed operations. An abscission agent should greatly improve its efficiency because most of the machine operating time is spent actually shaking the tree.

Results in this paper will primarily be restricted to the 'Valencia' variety, as extensive field tests on early and midseason oranges with chemical loosening agents and the intertia shaker are reported elsewhere (6). Chemicals tested in experiments on early and midseason oranges generally fell into 2 basic categories: "mass action" and "hormone level" chemicals. This classification was arbitrary, but served to distinguish the 2 classes of compounds. The former class usually comprises weak acids which require from 10,000 ppm (1%) to 50,000 ppm

(5%) to produce abscission activity. Such compounds generally produced acceptable abscission on early and midseason oranges with little or no leaf drop when 1 to 2% was sprayed on trees.[1] Both ascorbic acid (AA) and erythorbic acid (EA) performed well alone or in combination with citric acid (CA). Chief drawbacks to the use of the compounds were cost, fruit injury, and lack of effectiveness when rains occurred shortly after spraying. In California, low humidities have caused erratic results with both citrus (3) and olives (1). Evidently, humidities of 50% or greater (which are common under Florida conditions) are necessary for these type chemicals to be effective as abscission agents.

The "hormone level" compounds referred to chemicals which produced abscission activity at low concentration, although they were not necessarily hormonal in action. In contrast to previous seasons (2, 5), this class of chemicals (including iodoacetic acid) was ineffective during the 1967-68 fruit season.

Materials and Methods

Whole citrus trees were sprayed with various chemicals and pull tests were made on the fruit as described by Hendershott (2). Fifteen gallons of solution were applied per tree. Ortho spray sticker was also used in most treatments. Several commercial chemical companies furnished many of the products tested. Ratings of abscission inductiveness were based on the ability of the chemical to reduce the bonding force between the stem and the fruit.

For the abscission chemical-mechanical harvesting tests, six 'Valencia' orange trees were sprayed on May 25, 1968 with 2 lb AA plus 2 lb CA per tree. Six comparable trees were used as a control. Mature fruit and young fruit averaged 2.87 and 0.97 inches in diameter, respectively. Average Brix/acid ratio (4) of mature fruit was 16.9. The harvest treatments of both the sprayed and control trees consisted of maximal and minimal shaking periods. At maximum intensity, the object was to obtain removal of mature fruit regardless of removal of young fruit. Treatments were applied to single trees and replicated 3 times. Fruits were shaken onto canvas, collected, and counted.

[1]A 1% solution contains 1.2 lb of chemical dissolved in 15 gallons of water.

Results and Discussion

Results of spray tests with 'Valencia' oranges are shown in Table 1. "Hormone level" compounds, such as those with the commercial code designations of IMC 2167, HS-90, HS-4, and Ethrel, were generally ineffective. Ethrel (200 ppm) combined with AA (1 lb/tree) caused heavy defoliation, similar to the results of Ethrel sprays applied to early and midseason oranges (6).

AA (a "mass action" type compound) was generally effective in producing abscission of mature fruit, but injury to immature fruit usually occurred. However, immature fruit did not drop abnormally following treatment. Three lb per tree of AA or AA plus CA was necessary for removal of 'Valencia' oranges, although 2 lb per tree of these chemicals and combinations were sufficient to produce abscission of early and midseason oranges (6). EA was as effective as AA in tests with 'Valencia,' early, and midseason oranges.

Various additives were tested for their ability to increase the effectiveness of AA. CA, a relatively inexpensive acid, can substitute for part (but not all) of the AA or EA for 'Valencia' oranges (Table 1), or early and midseason oranges (6). CA alone, however, produced inconsistent abscission and excessive leaf drop. AD-7 (ferric ammonium citrate) was ineffective as an additive to AA, but the coded chemical F-8 substantially increased the abscission-accelerating qualities of AA.

Various weak acid or "mass action" compounds were tested. Some such as CZ-224 had no effect. CZ-371-C at ½ lb per tree produced fruit abscission, but caused tree injury (leaf drop and twig damage). Sulfamic acid at 1 lb per tree caused fruit abscission, but also severe tree injury. Partial buffering of sulfamic acid with sodium hydroxide (75 g) eliminated all tree injury, but also all abscission activity. Additional buffering experiments on sulfamic and other weak acids are planned during the 1968-69 fruit season.

Experiments with other weak acids showed that only one compound (HS-150) approached AA in abscission-producing ability (Table 1). The overall effect on the tree was very similar to AA. HS-150 is reported to be safe and relatively inexpensive, and extensive tests are planned with it on early and midseason oranges during the 1968-69 fruit season.

Table 1. Some chemicals tested for abscission accelerating activity on whole trees of 'Valencia oranges. Fifteen gallons of solution were applied per tree.

Chemical and concentration	Separation characteristics (3 days) Force lb	Plugs %	(6 days) Force lb	Plugs %
Ascorbic acid (AA) 1 lb/tree	13.0	90	13.7	87
AA or Erythorbic acid (EA) 2 lb/tree	10.1	60	11.0	70
AA or EA 3 lb/tree	8.0	45	4.2	6
AA (1 lb/tree) + Citric acid (CA) (1 lb/tree)	8.7	8	9.2	6
AA (1 lb/tree) + CA (2 lb/tree)	10.0	33	9.7	47
AA (2 lb/tree) + CA (1 lb/tree)	9.5	20	4.5	5
AA (2 lb/tree) + CA (2 lb/tree)	5.6	3	0.0	0
CA (3 lb/tree)	9.2*	23	11.3*	50
AA (1 lb/tree) + 200 ppm Ethrel	10.8*	70	10.2	67
Sulfamic acid (1 lb/tree)	9.9*	20	10.6*	23
Sulfamic acid (1 lb/tree) + 75 g NaOH	13.1	80	12.5	73
AA (2 lb/tree) + AD-7 (1/2 lb/tree)	13.9	57	11.4	80
IMC 2167 1,000 ppm	13.8	73	13.6	73
CZ-224 (1/4 lb/tree)	12.4	87	12.8	87
CZ-371-C (1/2 lb/tree)	8.5*	0	11.8*	27
HS-4 3,000 ppm	13.4	93	12.3	90
HS-90 2,500 ppm	14.0	90	14.4	77
HS-150 (2 lb/tree)	11.1	23	12.0	40
HS-150 (3 lb/tree)	8.0	20	9.6	33
HS-150 + CA (1 lb each/tree)	10.6	60	11.7	87
AA (1 lb actual/tree) + F-8 additive	9.5	20	8.8	10
AA (2 lb actual/tree) + F-8 additive	4.0	7	10.0	27
Control	13.5	90	13.5	90

*Heavy leaf fall occurred following treatment.

Results of the abscission chemical-tree shaker tests on 'Valencia' oranges are shown in Table 2. For the sprayed trees, an increase in shaking time per tree of 2½ times resulted in an increase of only 3.6 percentage points in percentage of mature fruit removed. By doubling the shaking time for the control trees, mature fruit removal was increased by 8.7 percentage points. The smaller increase for the sprayed trees is probably due to the higher percentage of mature fruit removed initially as a result of the abscission spray. Per cent mature fruit removal was from 7 to 11 percentage points higher for the sprayed trees than for the control trees.

The abscission spray decreased the detachment force of mature fruit about 50% without reducing it for the young fruit. Considering detachment force alone, one would expect that the shaker's selectivity between removal of mature fruit and young fruit would be increased; however, this was not true in this test. Selectivity, as indicated by the selectivity ratio, was decreased. This indicates that factors other than detachment force are confounded in the results of this test.

One important advantage of using the abscission chemical and subdued shaking intensity was that it reduced the number of fruit removed with adhering stems. These stems have to be removed later by hand. Percentage of fruit removed with adhering stems was reduced by 7 to 10 percentage points by use of the abscission spray, while only 2 to 5 percentage points reduction resulted from using minimal, rather than maximal shaking time.

Although no "hormone level" chemicals have consistently performed well, the weak acids or "mass action" type compounds produced generally acceptable abscission, particularly on early and midseason varieties, and may offer a partial solution to the problem of fruit abscission under Florida conditions. Expense is the biggest single drawback to the use of AA, although resulting peel injury would prevent its use on crops for a fresh fruit market. Any relief to the labor supply for harvesting concentrate grade fruit should, however, remove the pressure on fresh fruit harvesting. For the first time, experiments with 'Valencia' oranges were

Table 2. The effect of shaking intensity and abscission chemicals on the performance of the CES tree shaker on 'Valencia' oranges.

Shaking intensity	Shaking time (min.)	Mature fruit removal (%)	Selectivity* ratio	Detachment force Mature (lb)	Detachment force Young (lb)	Mature fruit removed with stems (%)
Sprayed with 2 lb AA + 2 lb CA + Ortho sticker						
Maximum	0.88	95.0	1.15	7.96	11.83	8.3
Subdued	0.37	91.4	1.38	7.96	11.83	6.4
Control						
Maximum	0.98	88.0	4.11	16.28	11.81	18.1
Subdued	0.47	79.3	3.00	16.28	11.81	13.3

All figures are the means of 3 replications except those for detachment force which are the means of 20 replications.

*Ratio between the number of mature to young fruit removed.

encouraging this season, but many problems remain.

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