FIELD TRIALS WITH POTENTIAL ABSCISSION CHEMICALS AS AN AID TO MECHANICAL HARVESTING OF CITRUS IN FLORIDA

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Abstract

During the 1967-68 season ascorbic acid and various additives, including citric acid and ferric ammonium citrate, were used successfully to aid mechanical harvesting of Hamlin, Pineapple, Jaffa, and Valencia oranges on a commercial basis. Ascorbic and citric acids are natural food products that are safe for human consumption. These two chemicals are now available for commercial use if needed by the industry. The greatest drawback to their use is the high concentration required, the prevalence of chemical injury to the rind, and the high cost. Chemical harvest sprays of ascorbic and citric acids offer little or no economic saving over manual harvest and can be used only on fruit moving rapidly to the concentrate plant.

Another chemical, cycloheximide, when used alone, was highly effective in inducing abscission of Valencia oranges at concentrations of 2 to 25 ppm. It has not been tested on other varieties and has not undergone extensive field trials on a commercial basis. Cycloheximide harvest sprays offer an economic saving over manual harvest. Its possible use in a spray mist for harvesting citrus for concentrate purposes without the aid of mechanical harvesters is discussed.

Introduction

As an orange fruit matures, a starch-filled layer of cells called the abscission layer develops in the rind across the veins around the button separating it from the fruit (8). When the fruit of some varieties are fully colored and remain attached to the tree for an additional 6 to 8 weeks, they usually abscise cleanly from the button at the abscission layer. This, however, does not occur readily in fruit with green rind adjacent to the button, even though the flesh of the fruit may have attained acceptable maturity standards for eating quality (3). Degreening of the rind of oranges usually occurs at the onset of cool weather in the winter, beginning at the stylar end and progressing gradually to the stem end. The rind adjacent to the button is the last portion to degreen. Different varieties of oranges vary in the degreening pattern. 'Pineapple' (*Citrus sinensis* [L.] Osb.) oranges are usually completely degreened when mature in January and February, and usually at this time separate readily at the button. If Pineapple fruit are not harvested at this time, preharvest fruit drop may occur. The rind of 'Valencia' (*Citrus sinensis* [L.] Osb.) oranges, on the other hand, may be degreened in March and later on in April and May will regreen at the stem end adjacent to the button. Such fruit may actually become more tightly attached to the fruit stem in May than they were in March (3).

When fruit is mechanically harvested and the cells of abscission layer have not begun to separate, a break or tear may take place through the parenchymatous tissue of the rind and a plug of tissue, including the button, is removed from the rind (4). Sometimes the fruit stem is broken, leaving a jagged woody stem attached to the fruit (4).

Accelerated development of an abscission layer, so that the fruit separates cleanly at the button, should greatly facilitate mechanical harvesting. Last year we reported that ascorbic acid (AA)[1] at concentrations of 2 to 5% hastens fruit abscission of Pineapple and Valencia oranges in Florida (3). Later, Rasmussen and Jones (7) found that AA-treated fruit produced enough ethylene to account for the fruit abscission.

With increasing evidence that ethylene is a plant growth regulator capable of controlling or influencing many developmental processes, it is also evident that a chemical which could induce

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[1]The following abbreviations are used for chemical names throughout this paper:
Ascorbic acid (AA)
2-Chloroethylphosphonic acid (ethrel)
Citric acid (CA)
Cycloheximide (CYH)
2,4-Dichlorophenoxy acetic acid (2,4-D)
Erythorbic acid or isoascorbic acid (EA)
Ferric ammonium citrate (FeAC)
Ferric ethylenediaminetetracetic acid (FeEDTA)
Indoleacetic acid (IAA)
Naphthalene acetic acid (NAA)

production of ethylene within a plant can be effective in increasing abscission. Until recently, IAA, NAA, and 2,4-D and related compounds (1) have been the most effective chemicals to induce ethylene in plants. Yet, when IAA, NAA, and 2,4-D are applied to citrus, fruit abscission is likely to be retarded because of the growth-promoting activity of these compounds. Because of this property of IAA, NAA, and 2,4-D, there has been considerable interest in finding compounds that induce ethylene in fruit but show no growth-promoting activity. CYH, ethrel, FeAC, AA, EA, and CA have this property (4, 6). The present paper describes experiments with these chemicals, to determine their relative effectiveness in hastening fruit abscission on trees of various orange varieties under commercial field conditions in Florida. In some of the tests the effectiveness of the abscission chemicals was evaluated by the use of mechanical harvesters. The purpose was not so much to evaluate harvesters per se, as to evaluate the abscission chemicals as an aid to mechanical harvesting.

Methods and Materials

The experiments were conducted with mature trees of 'Hamlin' [*Citrus sinensis* (L.) Osb.], Pineapple, 'Jaffa' [*Citrus sinensis* (L.) Osb.], and Valencia oranges. The FMC[2] airblast machine was used in four tests and a tree shaker was used in a single test. These machines are described elsewhere (2, 5). In the FMC airblast tests on Pineapple and Jaffa oranges, 10 trees were harvested after being treated with each of the three abscission chemical treatments (EA, EA + CA, and EA + FeAC), plus an untreated control. In two similar tests with Valencia oranges, 4 trees per treatment per test were used. Tree-shaker tests were conducted on 39 trees of Hamlin oranges treated with 3.5% EA.

In most of the tests with mechanical harvesters, EA and CA were used because these chemicals occur naturally in citrus and are presumed to be safe for human consumption. It was reported earlier (4) that AA and EA are equally effective in inducing abscission, and the results reported with one apply equally well to the other. The fruit from these tests were run through the concentrate plant, and palatability tests were made on the frozen concentrate.

In some of the mechanical harvesting tests, as noted under "Results and Discussion," additives to EA such as FeEDTA and FeAC were used, in order to try to lower the effective concentration of EA needed for abscission. CYH was used in two mechanical harvesting tests.

Additional work on ethrel and CYH was done on single trees or limb units with 45 to 100 fruits, and the efficacy of the treatments was tested by pull force tests and fruit drop counts after manually shaking the limbs. Records were also made of chemical injury to the fruit and defoliation resulting from the use of the various chemicals.

The methods of preparation and application of the spray solutions of the chemicals are described elsewhere (3). In one test a mist of a concentrated solution of CYH was used.

Results and Discussion

Tree shaker test.—In a single test 39 Hamlin orange trees were sprayed with a 3.5% EA solution on January 15, 1968. These were compared with a similar number of unsprayed trees. The trees were 30 feet tall and hedged on four sides; they had multiple trunks; and the bottom of the tree canopy was 6 feet aboveground. Such trees are suited for tree-shaker operations because the work can be performed under the canopy rather than through it. About 95% of the fruit was shaken from the tree, and all of it separated cleanly from the buttons. However, about 10% of the fruit was split, hitting the limbs on the fall to the ground from the tops of the trees. The 3.5% EA solution was apparently stronger than necessary to loosen Hamlin oranges at this time of the year; but the fruit and the older leaves were sensitive to 3.5% EA, and the leaf fall was 10%. Fruit from treated and untreated trees were made into concentrate at the U. S. Fruit and Vegetable Products Laboratory,[3] and there was no difference in the juice composition and flavor. The bulk of the fruit harvested from the test was concentrated by the South Lake Apopka Citrus Growers Association which reported that the concentrate was of good flavor. Because of a mechanical failure, untreated trees were not harvested with the shaker in this test.

[2]Food Machinery Corporation. Mention of a trademark name or a proprietary product does not constitute a guarantee or warranty of the product by the USDA, and does not imply its approval to the exclusion of other products that may also be suitable.

[3]The authors are indebted to Mr. Clifford Scott, U. S. Fruit and Vegetable Products Laboratory, Winter Haven, Florida, for providing this data.