Influence Of Temperature And Humidity On Cycloheximide-Induced Abscission And Ethylene Content Of Citrus

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ABSTRACT

Cycloheximide stimulated ethylene production in Hamlin oranges and Orlando tangelos more in 90°/70° than 60°/40° day-night controlled greenhouse conditions. Pull force generally decreased as the ethylene content increased, except for Orlando tangelos at low temperatures with both high and low humidity. Excessive premature fruit drop from the trees sprayed with 25 and 50 ppm cycloheximide occurred in the high temperature—high humidity conditions. Ethylene production in calamondin fruit was stimulated by cycloheximide at 50° and 70° but not at 40° F. Warm air temperatures in the field also increased the efficiency of cycloheximide in stimulating ethylene production and reducing the pull force of Hamlin oranges.

INTRODUCTION

Temperature and humidity influence many physiological processes in plants (6,9); among these are absorption and translocation of chemicals applied to the surface of leaves and fruit. More ethylene is produced by 'calamondin' fruit (**Citrus reticulata** var. **austera** ? X **Fortunella** sp ?) sprayed with ascorbic acid and grown in high humidity than when grown in low humidity (8). Pull force of the fruit is closely related to the amount of ethylene produced. Also, olive fruit abscise with less pull force after ascorbic acid treatment in humid conditions than dry (5).

The response of citrus fruits to ethylene producing chemicals under field conditions is variable (2,3,4, 10). Usually, temperatures, humidity, soil moisture, etc., were different in each test. Therefore, an understanding of the environmental conditions that affect the efficiency of these abscission chemicals is desirable, so that

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with more sophisticated inhibitors that could turn-on or turn-off specific reactions to increase or decrease synthesis of a particular compound or group of compounds.

The temperature profile-response in Figure 1 shows that the temperature required to decrease acidity is probably determined by the metabolic rate necessary to evoke the response. At 92° F the temperature was too low and at 110° F the metabolic rate was so high that oxygen-diffusion was probably rate limiting and the anaerobic response was obtained with air. Therefore, the optimum chamber temperature for gas treatment should be about 104° F to evoke a response in 20 hours with grapefruit initially at 70° F.

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References to specific commercial products do not constitute endorsement.

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they may be applied at the best time.

Cycloheximide (3 [2-(3,5-dimethyl-2-oxocyclohexyl) - 2 - hydroxyethyl] glutarimide) stimulates ethylene production by a number of plants (1,2,4) including citrus. It is one of the most promising chemicals to induce abscission of citrus fruit. However, the pull force of fruit from their stems after cycloheximide application is variable, depending on environmental conditions.

We grew small citrus trees in cans in a greenhouse with temperature and humidity control to determine how these two factors affect ethylene production and pull force of fruit after they are treated with cycloheximide. To determine whether the temperature effect was the same in the field, we monitored temperatures during several tests. We also report the results of several 24-hour temperature tests with calamondin fruit dipped in cycloheximide.

Field tests. -- Temperature records during two field tests show the relation of air temperatures to ethylene production and pull force of Hamlin oranges. The average maximum and minimum temperatures in one test were 70° /54° and during the other 63° /37° . We applied 10 gal of spray with 0, 5, 10 or 25 ppm cycloheximide and 0.1% triton x-100 to single trees. Data represent the average ethylene content of five fruit from each of four replications, and the pull force of 10 fruit from each replication 5 days after spray application.

RESULTS AND DISCUSSION

Effect of temperature and humidity in controlled conditions. -- Ethylene in the fruit increased at nearly the same rate as cycloheximide concentration increased under high temperature. The two humidity ranges used had no effect on ethylene production by Hamlin oranges (Table 1). The pull force required to remove the fruit from their stems decreased as ethylene increased up to about 0.77 ppm. Above that level, the pull force remained nearly constant but more fruit dropped prematurely than at the lower ethylene levels when the humidity was high. In low humidity even the highest ethylene concentration had little effect on the number of fruit drops.

In the low temperature test on Hamlin oranges (Table 2), cycloheximide did not increase ethylene production as much as in the high temperature. The maximum amount in low temperature was 1.42 ppm compared to 2.75 ppm in high temperature. Under the high humidity the pull force decreased as cycloheximide concentration increased but when the humidity was low (40/60% RH), the treatments affected the pull force very little. Only the 50 ppm treatment in high humidity increased the number' of premature drops.

The same general trends exist when cycloheximide is sprayed on Orlando tangelos in the same growing conditions (Tables 3 and 4). However, the ethylene content was never as high in Orlando tangelos as in the Hamlin oranges under similar conditions. Untreated Orlando tangelos contained slightly more ethylene than the untreated Hamlin oranges, and they separated from their stems with less force than did the Hamlins. This observation is expected since low pull force is generally correlated with high ethylene levels.

In high temperature, even though ethylene was lower, the pull force of the Orlandos was reduced to nearly the same level as that of the Hamlin oranges. Seventy per cent of the fruit dropped in the high humidity-high temperature treatment as compared to about 10% in low humidity.

Cycloheximide increased the ethylene least of all in Orlando tangelos in the 60° /40° regime (Table 4). The treatments did not reduce the pull force in these environmental conditions, even though ethylene increased up to .64 ppm. No increase in drops occurred under these conditions.

Ethylene evolution from calamondin fruit. -- To further test the effect of temperature on the efficiency of cycloheximide, we dipped calamondin fruit in solutions of cycloheximide as described. Cycloheximide at 5 and 10 ppm stimulated ethylene production in these conditions at 50° and 70° but not at 40° F. The rate of ethylene production increased rapidly in the 5 and 10 ppm treatments at 50° and 70° . Higher temperatures may have increased it even more since field and greenhouse data indicate increased ethylene production by other citrus varieties up to 90° F. Also, ascorbic acid increased ethylene production more at 80° than at lower temperature under similar conditions (unpublished data).

Field tests. -- Cycloheximide stimulated ethylene production by Hamlin oranges more when the average temperatures were 74°/52° day-night than when they were 63°/37° day-night. Almost five times as much ethylene was produced by 5 ppm cycloheximide in the higher temperatures. The fruit sprayed with 25 ppm cycloheximide contained about two times as much ethylene in the higher temperatures (Fig. 2).

The pull force decreased more rapidly in the high temperature test. The 5 ppm treatment reduced the pull force to about 9 lbs compared to 14.5 lbs in the low temperature. The pull force did not go below 10 lbs during the cold temperatures regardless of cycloheximide treatment, while it went down to about 8 lbs in the warmer temperature when 25 ppm cycloheximide was used.

Table 1. Ethylene content, pull force of fruit and fruit drop of Hamlin oranges sprayed with cycloheximide and grown in high temperatures 1/

Cycloheximide ppm	C_2H_4 2/ ppm	Pull force lbs	Drops 3/ number
High Humidity (80%100%)			
0 (H_2O)	0.02	16	0
5	0.34	12	0
25	0.77	2	6
50	2.59	3	10
Low Humidity (40/60%)			
0 (H_2O)	0.03	16	0
5	0.28	14	1
25	0.85	5	4
50	2.75	4	3

1/ 90°/70° day-night.
2/ Ethylene under rind of fruit.
3/ Number of fruit drops out of 20 original

Table 2. Ethylene content, pull force of fruit and fruit drop of Hamlin oranges sprayed with cycloheximide and grown in low temperatures 1/

Cycloheximide ppm	C_2H_4 ppm	Pull force lbs	Drops Number
High humidity 1/			
0 (H_2O)	0.05	12	0
5	0.24	13	0
25	0.78	9	0
50	1.42	5	4
Low humidity			
0 (H_2O)	0.03	19	0
5	0.23	18	0
25	0.36	18	0
50	0.89	16	0

1/ 60°/40° day — night.

Table 3. Ethylene content, pull force and drop of Orlando tangelo fruit of trees sprayed with cycloheximide and grown in high temperatures 1/

Cycloheximide ppm 2/	C_2H_4 ppm	Pull force lbs	Drops number
high humidity 2/			
0 (H_2O)	0.06	9	0
5	0.44	6	3
25	0.87	2	8
50	1.97	4	14
low humidity			
0 (H_2O)	0.05	12	0
5	0.48	8	0
25	0.97	2	1
50	1.72	3	2

1/ 90°/70° F day — night
2/ See Table 1.

In other field tests during cold weather we found that the temperature at the time of application was as important as temperatures after application. Usually a warm day soon after spray application had more effect on cycloheximide than one closer to harvest date. Both pull force and ethylene production by the fruit indicated this. The most likely reason is that the half-life of cycloheximide is relatively short in these conditions, so that the temperature soon after application is more important than that closer to harvest.

Table 4. Ethylene content, pull force of fruit and fruit drop of Orlando tangelos sprayed with cycloheximide and grown in low temperatures 1/

Cycloheximide ppm	C_2H_4 ppm	Pull force lbs	Drops number
	High humidity 2/		
0 (H_2O)	0.04	10	0
5	0.29	10	0
25	0.62	10	0
50	0.54	11	2
	Low humidity		
0 (H_2O)	0.05	11	0
5	0.28	10	0
25	0.58	11	1
50	0.64	9	0

1/ 60°/40° F day — night.
2/ See Table 1.

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Maintaining Market Quality Of Florida Avocados [1]

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ABSTRACT

Market quality of avocados is maintained by a sequence of procedures beginning with the selection of improved varieties and proper production practices and progressing through the storage, transportation, and marketing of the fruit.

In Florida, the avocado harvesting and marketing season usually begins in June and ends in February. Maturity standards have been established for each variety and must be met as specified in a Federal Marketing Agreement. The standards are based on either minimum fruit weights or diameters which must be attained on designated shipping dates.

The optimum storage condition for 'Booth 1,' 'Booth 8,' 'Lula' and 'Taylor' avocados, which are cold-tolerant varieties, is 40° F., for approximately a month. The optimum storage condition for West Indian varieties such as 'Fuchs,' 'Pollock' and 'Waldin' is 55° for two weeks. The optimum ripening temperature for Florida avocados is 60° .

Recent findings indicate that 'Lula' avocados can be stored successfully for 60 days in a controlled atmosphere (CA) of 1% O_2+9% CO_2 at 50° F.

INTRODUCTION

The avocado (**Persea americana** Mill.), which originated in tropical America, is becoming increasingly popular with consumers in the temperate zones. This increasing popularity is indicated by the increased production of avocados in the United States. During the period from 1929 through 1961, the production increased at a rate of 10.2% a year (Markeson, 1963). The extensive development of rapid modern transportation and refrigeration facilities has enabled the industry to move high quality produce from the grove to the consumer.

The avocado is grown throughout the tropical and sub-tropical world, most often as seedling and dooryard trees in Central America, Mexico, and the West Indies. The largest commercial plantings of grafted trees of named varieties are found in Israel, South Africa, and the United States, especially in peninsular Florida and southern California. Excluding citrus, the avocado ranks third after the banana and the pineapple in export trade (non-local consumption) of tropical fruits (Ochse, **et al**, 1961).

For centuries the avocado, which possesses high nutritional value, has been a basic food crop in its indigenous area; however, commercial production in the United States did not begin until about the turn of the century. In 1967, about 14,700 tons of avocados were shipped from Florida; this represented over 5200 acres of commercial plantings. For the same year, the combined production from Florida and California was reported as 53,200 tons, having a value in excess of $22 million (U. S. Dept. of Agr., 1968).

SELECTION OF COMMERCIAL VARIETIES

Some of the factors to be considered when avocado varieties are chosen for planting are size, color, and time of maturity of the fruit.

In 1920 Popenoe classified avocados into the West Indian, Guatemalan, and Mexican races. Recently the classification has been less distinct because of the increasing number of hybrid varieties and the discovery of intermediate types (Popenoe and Williams, 1947, Schroeder, 1947).

Avocados of the West Indian race are intolerant to cold and thus are confined largely to the tropical lowlands. In the continental United States, West Indian varieties are grown commercially only in southern Florida. The fruit matures during the summer and fall and has a relatively low oil content. 'Waldin' is the leading variety, followed by 'Pollock'.

Avocados of the Guatemalan race, and especially those of the Mexican race, are higher in oil content and are more tolerant to cold than those of the West Indian race. Most of the commercial varieties in Florida are West Indian x Guatemalan hybrids of

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