ABSCISSION OF CALAMONDIN FRUIT AS INFLUENCED BY HUMIDITY, ASCORBIC ACID AND COPPER

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Abstract

We placed 'calamondin' [*Citrus reticulata* var. *austera* ? X *Fortunella* sp ?] trees in two growth chambers programmed for two relative humidities, i.e. 1) 50% day - 95% night; and 2) 25% day — 50% night. Temperatures and light were the same in both chambers. The pounds of force required to separate the fruit from their stems was lowered by pre-conditioning of the trees for 1 week in the high humidity chambers; and by treatments with 1% ascorbic acid (AA), 1% AA + 0.1% CuEDTA and 0.5% AA + 0.1% CuEDTA. All treatments were more effective in high humidity than low; and 1% AA + 0.1% CuEDTA was the most effective spray tried. Ethylene in the internal atmosphere of the fruit increased because of the treatments and it was highest when the pounds of force required for fruit separation was lowest.

Introduction

Ascorbic acid (AA) stimulated abscission of olive fruit (4) and 'Pineapple' and 'Valencia' orange (*Citrus sinensis* [L.] Osb.) fruit (1, 2) under field conditions. The induction of abscission of olive fruit was greater under humid conditions than dry. The effectiveness of AA on inducing abscission of citrus fruit was variable in the field and this may be associated with humid nights or continuous high humidity. Humidity does influence the water relations and, in turn, several physiological processes in plants (6, 7, 10). One process influenced is absorption of chemicals; and in the present case humidity may influence the absorption of AA.

Copper (Cu) from CuEDTA as well as AA alone increased ethylene production by calamondin fruit (9); and Cu also increased the effectiveness of AA in citrus fruit abscission (8). Therefore, we used calamondin trees under controlled conditions to determine the effect of humidity on citrus fruit abscission when the trees have been sprayed with AA or AA + Cu. We also measured ethylene in the internal atmosphere of the fruit to show the relationship between pounds of force required to remove the fruit and the ethylene production in the fruit.

Methods and Materials

We put 2-year-old calamondin trees with 10-15 ripe fruit in two growth chambers. One was programmed for 50% relative humidity (RH) days and 95% RH nights, and the other was for 25% RH days and 50% RH nights. The temperature in both chambers was 75° day and 45° night, each of 12-hour duration. The humidity, light and temperatures were changed gradually in the chambers to approximate outdoor conditions. Fluorescent tubes and incandescent bulbs provided about 6000 ft-c of light for 9 hours during the day.

One set of calamondin trees was exposed to the growth chamber conditions for 1 week before sprays were applied. We sprayed the other set the day we put them in the chambers with 1% AA, 1% AA + 0.1% CuEDTA, 0.5% AA + 0.1% CuEDTA, or H_20. Triton X-100 at 0.01% was used as wetting agent. We used four replications in each set or a total of 64 trees.

The pounds of force (pull force) required to separate the fruit from their stems was determined by previously described methods (5, 8).

Ethylene was determined in a 2-ml sample taken with a syringe from the internal atmosphere of five fruit from each treatment. These samples were injected into a gas chromatograph with the same operating conditions as previously described (8, 9) for ethylene determinations. The basic conditions were a 30°C oven; dual flame detectors with a hydrogen-oxygen flame; and a nitrogen flow rate of 40 ml/min through 6 foot X 1/8 inch columns packed with activated alumina.

Results and Discussion

Effect of preconditioning.—One week of preconditioning before spray application lowered the pull force of the calamondin fruit from the high humidity chamber. The pull force of the untreated and 1% AA treated fruit was about 50% lower than that of the non-preconditioned fruit. Also, the 1 week preconditioning at 20/50% RH did not lower the pull force of the fruit except for that of the untreated (compare Tables 1 and 2). The reason for the effect on the untreated but not the treated fruit cannot be explained, except by suggesting that the treatments may have a dominant effect.

Effect of AA and AA + Cu sprays.—Under high humidity the 1% AA treatment reduced the pull force of the fruit by 2 lbs and the 1% AA + 0.1% CuEDTA treatment reduced this pull force by a factor of 2 (Table 1). Under low humidity 1% AA was as effective as under high humidity, but CuEDTA had no effect in lowering the pull force. Less AA (0.5%) + 0.1% CuEDTA also lowered the pull force when compared to that of the untreated or 1% AA treated fruit under high humidity conditions. The pull force of these fruit was 2.7 lb versus 4.1 lb for the fruit treated with 1% AA (Table 1).

The percent decrease in pull force of the fruit from the preconditioned trees was not as great as that for the non-preconditioned fruit. However, the absolute pull force in pounds of force decreased considerably especially under high humidity (Table 2). One percent AA + 0.1% CuEDTA lowered the pull force to 1.3 lb. This was the most effective treatment and the data show the combined effect of high humidity plus 1% AA + 0.1% CuEDTA. CuEDTA + 1% AA was effective under low humidity also, in that the pull force was lowered from 3.1 to 2.5 lb compared to 1.9 to 1.3 lb under high humidity.

Ethylene in the internal atmosphere of calamondin fruit.—Ethylene in the internal atmosphere of untreated fruit was too low to be detected even in the fruits from the high humidity chambers. These fruit separated from their stems at a lower pull force than did the fruit from the low humidity chamber (Table3).

Table 1. Pounds of force required to remove calamondin fruits from their stems 5 days after the trees were sprayed with ascorbic acid and Cu

Treatment	Force (lbs)	
	50/95[1]	25/50
Untreated	6.0 a	5.2 a
1.0% AA	4.1 b	3.0 b
1.0% AA+0.1% CuEDTA[2]	2.0 c	3.1 b
0.5% AA+0.1% CuEDTA	2.7 c	3.6 b

1/ Relative humidity day/night
2/ Cu from CuEDTA
3/ Figures sharing a letter in columns do not differ significantly at odds of 19:1.

Table 2. Pounds of force required to remove calamondin fruits from the stems of preconditioned[1] trees 5 days after being sprayed with AA and Cu

Treatment	Force (lbs)	
	50/95	25/50
Untreated	3.4 a	4.2 a
1.0% AA	1.9 b	3.1 b
1.0% AA+0.1% CuEDTA	1.3 c	2.5 c
0.5% AA+0.1% CuEDTA	2.1 b	3.6 b

1/ Preconditioned 1 week in growth rooms at the two humidities indicated prior to spraying.
2/ See Table 1 for statistical evaluation.

Generally, the internal atmosphere of the treated preconditioned fruit contained more ethylene than that of the treated non-preconditioned fruit. AA stimulated ethylene synthesis, and in most cases 0.1% CuEDTA further stimulated ethylene synthesis. Detached calamondin fruit treated with AA in jars also produced more ethylene in the presence of Cu (9). More ethylene was found in the treated fruit from the high humidity grown trees than from the low.

Relation of ethylene to pull force.—As the ethylene content increased in the internal atmosphere, the pull force for separation of fruit from their stems decreased (Fig. 1). High humidity as well as ethylene lowered the pull force of these fruit. What effect humidity has

Table 3. Ethylene in the internal atmosphere of calamondin fruits sprayed with AA and Cu exposed to two humidity climates

Treatment	ppm C_2H_4	
	50/95	25/50
	Preconditioned	
Untreated	0.00 a	0.00 a
1.0% AA	0.37 b	0.32 b
1.0% AA+0.1% CuEDTA	0.58 c	0.39 b
0.5% AA+0.1% CuEDTA	0.52 c	0.30 b
	No preconditioning	
Untreated	0.00 a	0.00 a
1.0% AA	0.17 b	0.15 b
1.0% AA+0.1% CuEDTA	0.32 c	0.29 c
0.5% AA+0.1% CuEDTA	0.18 b	0.12 b

1/ See Table 1 for statistical evaluation.

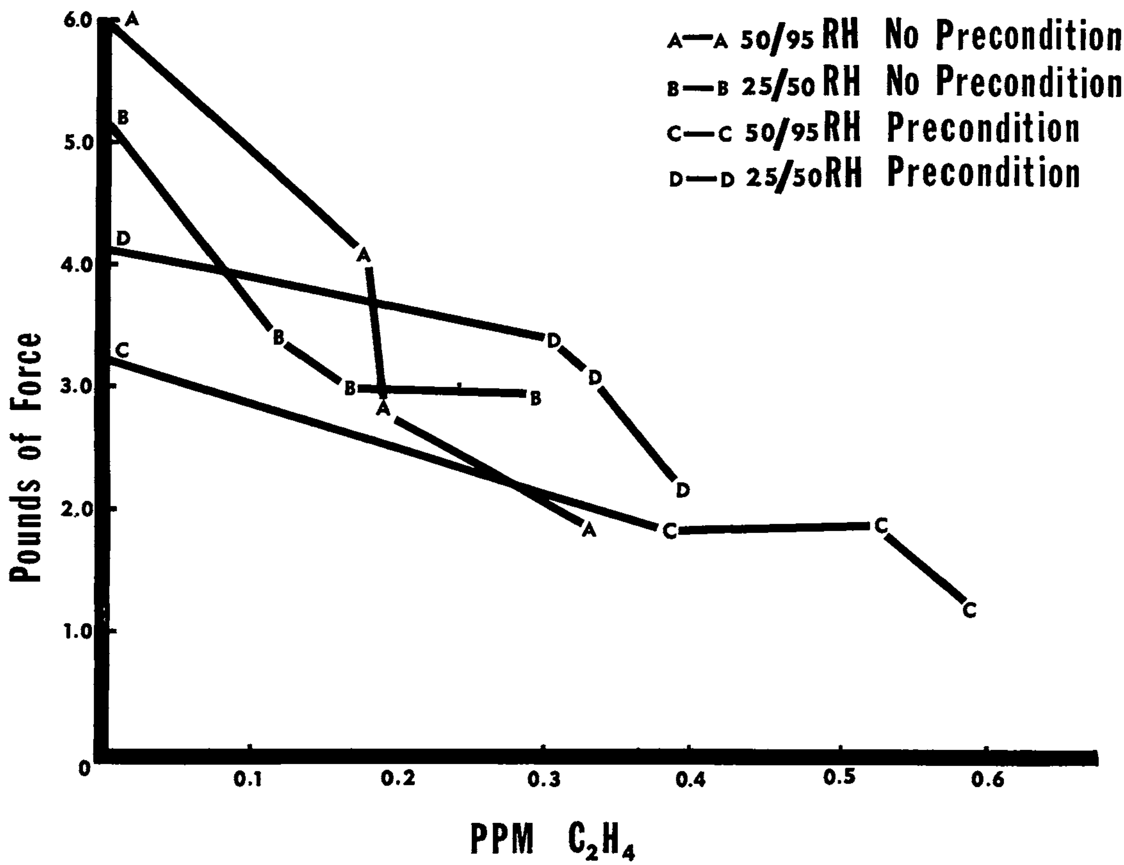

Figure 1.—Pull force of Calamondin fruit from their stems of 2-year-old trees grown under found conditions versus internal atmosphere ethylene.

is not known, except for its influence on internal water relations and its effect on absorption of spray materials. These effects should be similar to those in other plants (7, 10).

Since fruit was nearly mature, the more favorable conditions for maturation may cause it to age enough to become more susceptible to the ethylene produced. More spray material may be absorbed under high humidity, and therefore more ethylene may be produced. We do not know whether the high humidity fruit absorbed more of the spray material than the low humidity fruit. However, Table 3 indicates this, since the internal atmospheres of the high humidity fruit contained more ethylene than that of the low humidity fruit. The cells of the fruits may be more susceptible to injury under high humidity; and if the ethylene produced by the fruits treated with AA and Cu is a result of injury (8), then more ethylene would be produced under high humidity.

Non-wounding physical stress will increase ethylene production by pea epicotyls (3). The same reaction can take place in citrus fruits in some instances. For example, we found that when we subjected calamondin trees to extremely low moisture (both humidity and soil) causing stress which resulted in abscission of calamondin fruit at a lower pull force than when the soil moisture was adequate (unpublished data).

Under field condintions other factors as well as soil moisture and humidity no doubt affect the pull force of citrus fruit. The length of time the soil is dry, amount of rain at any one time and the time of the rain in relation to time of spray application may be as important as the soil moisture at the time the pull force measurements are made. The pull force data in this paper are separation forces of calamondin fruit from young trees growing in pots. Therefore, the data may be some different than field data even though high humidity had a direct influence on the efficiency of the chemicals used in this test.

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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.

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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