are frequently low (4). Furthermore, the prices for larger sizes are generally higher than for smaller sizes. Thus, net return per acre depends not only on overall packout but also on the actual size distribution of the fruit.

Many factors influence the costs of chemical thinning and the returns expected. More important than the actual cost of material probably will be the confidence with which NAA can be used and the ease with which it can be incorporated into the overall spray program. Returns from thinning will depend on the improved packout achieved, the relationship between fruit size and market prices, the presence of market size restrictions, and the value of eliminations.

General comment. Application of NAA to 'Dancy' tangerines during years of excessive crops shows promise for improving fruit size and reducing alternation of heavy and light crops. However, many factors influence both the amount of natural abscission and the influence of NAA, making it difficult to predict accurately the amount of thinning that will be achieved. Practical implementation will require careful integration of chemical fruit thinning with existing hedging and topping programs, irrigation, and other management practices. Careful analysis of relative costs and benefits will be required.

Performance and residue data for NAA have been obtained in both California and Florida and registration is being sought. At present, however, it is illegal to apply NAA to citrus.

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INFLUENCE OF ROOTSTOCK ON CITRUS FRUIT ABSCISSION RESPONSE TO CYCLOHEXIMIDE TREATMENT

W. C. Cooper and W. H. Henry

Agricultural Research Service, USDA
Orlando

Abstract. **Experiments were conducted during April and May at a location in Clermont, Fla., where 'Valencia' orange, Citrus sinensis (L.) Osbeck, trees on rough lemon, C. limon (L.) Burm. f.; 'Cleopatra' mandarin, C. reticulata Blanco; and sour orange, C. aurantium L., rootstocks were sprayed with cycloheximide (CHI) for stimulating fruit abscission. Fruit on trees on sour orange and 'Cleopatra' mandarin rootstocks loosened much more readily than fruit on trees on rough lemon rootstock. Fruit on 'Valencia' orange trees on 'Carrizo' citrange, C. sinensis X Poncirus trifoliata (L.) Raf., rootstock at a nearby location were also readily loosened by cycloheximide treatment. A survey revealed that CHI-induced fruit abscission was always greater on trees on sour orange rootstock than on those on rough lemon.**

When 10 to 20 ppm cycloheximide (CHI) is sprayed on citrus trees, it reacts with the flavedo sufficiently to stimulate the fruit to generate ethylene at rates of 0.5 to 5.0 ppm, which loosens the fruit (1). Treated 'Hamlin' and 'Pineapple', *Citrus sinensis* (L.) Osbeck, oranges are usually more responsive than 'Valencia' oranges, *C. sinensis*, (3) in both ethylene production and fruit loosening. Also, considerable variability in the responsiveness of any cultivar to CHI treat-

[1]This is a report on the current status of research involving use of certain chemicals that require registration under the Federal Environmental Pesticide Control Act (FEPCA). This report does not contain recommendations for the use of such chemicals, nor does it imply that the uses discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.

ments results from cultural practice, fruit maturity, and climate (4).

In 1971, we observed that 'Valencia' oranges on rough lemon rootstock at Lake Wales were generally less responsive to CHI treatments than 'Valencia' oranges on sour orange rootstock at Ft. Pierce (2). During the past season we tested the responsiveness of 'Valencia' oranges on 3 rootstocks growing in adjacent rows at the same location. In this paper, we deal with practical aspects of the rootstocks effects on the chemical control of citrus fruit harvest.

Materials and Methods

Bearing 15-year-old 'Valencia' orange trees on rough lemon (RL), *C. limon* (L.) Burm. f., sour orange (SO), *C. aurantium* L., and 'Cleopatra' (Cleo) mandarin, *C. reticulata* Blanco, rootstocks, in adjacent rows in a planting at Clermont, Fla., were used in an experiment conducted in May. Other experiments with 8-year-old 'Valencia' oranges on 'Carrizo', *C. sinensis* X *Poncirus trifoliata* (L.) Raf., rootstock in a grove at Windermere were not designed to test rootstock effects, but the data provide useful information on the effect of this rootstock.

In each experiment, single-tree replicates in three blocks of each scion-rootstock were sprayed with 20 ppm CHI, and another set was sprayed with 20 ppm CHI, plus 1,000 ppm succinic acid 2,2-dimethyl hydrazide (SADH)[1]. Procedures for spraying trees and determining *fruit removal* force (FRF) are described elsewhere (4). The percentage of small-fruit drop and leaf drop on treated trees was determined by tagging 3 branches on each tree and counting small fruit and leaves before treatment and at weekly intervals after treatment, until small-fruit and leaf drop had ceased. We also determined the percent fruit drop resulting from manually shaking selected branches vigorously for 10 sec. We refer to this as the simulated-harvest record.

Results

CHI, applied on May 25, was more effective in inducing abscission of 'Valencia' oranges on sour orange and 'Cleopatra' rootstocks than on rough lemon (Table 1). This is indicated by both the FRF measurements and the simulated-harvest determinations. Whereas only 65% of the fruit was removed by shaking trees on rough lemon, 91 and 88% of the fruit was removed from trees on sour orange and 'Cleopatra' mandarin. Fruitlet and leaf drop data were erratic, but appeared to be influenced by other unknown factors more than by CHI treatment on rootstock.

In other experiments, sprayed 'Valencia' orange on 'Carrizo' citrange rootstock made greater abscission responses than did similar trees at another location on rough lemon (Table 2). The differences in abscission response between these two rootstocks, though at different

Table 1. Abscission response of Valencia orange on Rough lemon (RL), sour orange (SO), and Cleopatra mandarin (Cleo) to cycloheximide (CHI) and CHI plus 2,2-dimethyl hydrazide (SADH) treatments. Experiment conducted in replicated field planting at Hartle's Grove, Clermont on May 25, 1973

Treatments[z]	Rootstock	FRF	Simulated harvest	Fruitlet drop[y]	New-leaf drop	Old-leaf drop
		(lb)	(%)	(%)	(%)	(%)
CHI	RL	7.0	65	20	2	7
	Cleo	5.9	88	32	2	4
	SO	5.5	91	10	0	9
CHI + SADH	RL	4.1	94	14	2	11
	Cleo	3.6	100	6	2	3
	SO	3.5	100	20	0	3

[z]/20 ppm CHI and 20 ppm CHI + 1,000 ppm SADH - 85.

[y]/Fruit drop on controls were 26% for RL and Cleo and 17% for SO.

Table 2. Abscission response of Valencia oranges on Carrizo citrange and rough lemon (RL) rootstocks when treated with 20 ppm cycloheximide (CHI) in nonrandomized experiments at two locations during 1973

Date of treatment	Rootstock	Location	FRF	Simulated harvest
			(lb)	(%)
3/21	Carrizo	Windermere	5.6	87
3/23	RL	Clermont	9.1	65
6/11	Carrizo	Windermere	2.5	100
5/29	RL	Clermont	11.0	60

locations, are substantial enough to seem of practical importance.

Because of the indicated rootstock effect on the abscission responsiveness of 'Valencia' oranges, we checked on rootstocks of 'Pineapple' orange trees sprayed with CHI in other tests conducted during the years 1969 through 1973. In all years, the abscission response of CHI-treated trees on sour orange rootstock was greater than that of CHI-treated trees on rough lemon rootstock (Table 3).

The addition of 1,000 ppm SADH to CHI increased the effectiveness of CHI on 'Valencia' oranges on all rootstocks (Table 1). The simulated-harvest record was well above 90% for all trees on all rootstocks. Fruitlet and leaf drop were no more severe on any treated trees than on control trees.

The harvest record of 'Valencia' orange trees on rough lemon sprayed with CHI alone is not high enough during April and May to be commercially profitable. However, when the trees are sprayed with CHI + SADH during this period, the FRF levels are lowered to near 5 lb. and the simulated harvest is about 90%. (Table 4). Fruitlet and leaf drop were no more severe for this treatment than for the untreated controls (Table 4). Although fruitlet drop on all treatments and controls is high for April 18 and May 4, it is greatly reduced by the May 25 date of application.

Discussion

CHI is more effective on 'Valencia' orange on sour orange, 'Cleopatra', and 'Carrizo' rootstocks than on rough lemon. These rootstock effects explain some of the variabilities in responsiveness of

Table 3. Abscission response of Pineapple oranges on rough lemon (RL) and sour orange (SO) rootstocks to cycloheximide (CHI) treatments in miscellaneous experiments during 1969-73

Rootstock variety	Location	Date treated	Conc. CHI	FRF	Simulated harvest
			(ppm)	(lb)	(%)
SO	Winter Garden	2/18/69	5	5.8	*
			10	5.5	*
RL	Lake Hamilton	2/20/69	5	9.0	*
			10	9.0	*
SO	Windermere	12/8/71	10	3.5	100
		1/12/72	10	3.8	100
		2/29/72	10	2.5	100
RL	Windermere	1/19/73	10	9.4	40
		2/6/73	10	6.1	75
		2/22/73	10	7.1	65

*No simulated harvest records were made on these tests, but the test trees were harvested with the FMC air-blast machine. 100% harvest was achieved on the trees on SO, whereas only 90% was achieved on trees on RL.

Table 4. Abscission response of Valencia orange on Rough lemon (RL) to cycloheximide (CHI) and CHI + 2,2-dimethyl hydrazide (SADH)[z] treatments during April and May 1973

Date treated	Treatment	FRF (lb)	Simulated harvest (%)	Fruitlet drop (%)	New-leaf drop (%)	Old-leaf drop (%)
4/18	Control	18.7	5	97	21	8
	CHI	7.9	65	95	5	10
	CHI + SADH	5.3	94	97	7	17
5/6	Control	17.6	3	90	26	20
	CHI	8.1	70	96	25	8
	CHI + SADH	5.5	88	87	0	15
5/28	Control	19.8	1	27	1	8
	CHI	7.5	65	20	2	7
	CHI + SADH	4.0	94	14	2	11

[z]20 μg/ml CHI and 850 μg/ml SADH used.

'Valencia' oranges to CHI treatments observed in earlier fruit-abscission work (1, 2, 3, 4). The same rootstock effect also occurs with 'Pineapple' oranges and possibly for all citrus cultivars. By use of 10 ppm CHI, early and midseason oranges on sour orange, 'Cleopatra', and 'Carrizo' rootstocks can be harvested. However, 'Pineapple' oranges on rough lemon rootstocks may require 20 ppm CHI to induce adequate fruit-loosening.

Our results suggest that 'Valencia' oranges on sour orange, 'Cleopatra', and 'Carrizo' rootstocks are likely to be successfully loosened by 20 ppm CHI. However, this should be confirmed by more extensive field trials, including the effect of CHI on the "set" of the new crop. If the results are confirmed, there is more opportunity for the successful use of CHI on 'Valencia' oranges in the north central and Indian River regions, where sour orange rootstock predominates, than on the Ridge, where rough lemon predominates.

Adding 1,000 ppm SADH to 20 ppm CHI offers some promise for the harvest of 'Valencia' oranges on rough lemon rootstock. SADH alone (concn of 500 to 5,000 ppm were tested) will not loosen fruit (4, 5). Also, 20 ppm CHI + 500 ppm SADH is generally ineffective. To be effective, 1,000 ppm SADH should be combined with the CHI treatment (4, 5).

The CHI treatment is now an accepted commercial practice for the loosening of early and midseason oranges in Florida. Also, during the past season, more than 1,000 acres of 'Valencia' oranges were treated with CHI. By use of the SADH amendment to CHI, it may be possible to exploit the use of CHI further for the successful commercial harvest of 'Valencia' oranges. During this next orange season, we plan to extend our studies on the use of the SADH-CHI treatment to loosen 'Valencia' oranges on rough lemon rootstock.

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