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LOOSENING OF ORANGES WITH PIK-OFF, RELEASE, ACTI-AID AND SWEEP COMBINATIONS[1]

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Abstract. **Glyoxal-dioxime (Pik-Off) combined with cycloheximide (Acti-Aid) and chlorothalonil (Sweep) loosened 'Hamlin' and 'Valencia' oranges. The fruit removal force (FRF) of 'Hamlin' oranges was lowered to about 5 lb (2.3 kg) and that of 'Valencia' oranges to 4 to 7 lb (1.8 to 3.2 kg). 'Valencia' oranges responded more erratically than 'Hamlin', especially during May, the "nonresponsive" period. The combination of 75 ppm Pik-Off, 5 ppm Acti-Aid plus 100 ppm Sweep lowered the FRF to an acceptable level in 3 to 5 days with no excessive defoliation or fruit damage when surfactants were added to the sprays. Defoliation was not a problem in any of the tests, however; young 'Valencia' fruit were damaged by 150 ppm Pik-Off or 10 ppm Acti-Aid. Pik-Off combined with 5-chloro-3-methyl-4-nitro-1H-pyrazole (Release) and Sweep loosened 'Valencia' oranges in April but not in May or June.**

Cycloheximide (Acti-Aid), glyoxal dioxime (Pik-Off), 5-chloro-3-methyl-4-nitro-1H-pyrazole (Release) and chlorothalonil (Sweep) have been used in Florida for loosening citrus fruit and thus facilitating mechanical harvesting (1, 2, 3, 4). Most combinations of Release, Acti-Aid and Sweep are more effective than the individual chemicals (6).

The response from Pik-Off has been variable (3); hence, it has not been widely accepted by the industry. Release and Pik-Off have been cleared by EPA for only experimental use on citrus. Because Pik-Off apparently has not been used in combination with other fruit-loosening chemicals, I undertook to determine whether or not Pik-Off combination sprays would be as effective as other combination sprays and more effective than Pik-Off alone. Pik-Off combinations have been used in our field tests the past 2 years and results from several combinations with Acti-Aid and Sweep used on 'Hamlin' and 'Valencia' (*C. sinensis* (L.) Osbeck) oranges for loosening of the fruit will be reported.

Materials and Methods

The concentration of chemicals and dates of application for each cultivar are given in the results. Several concns of Pik-Off, Release, Acti-Aid, Sweep, and Triton X-100 were tested in combination sprays. Triton X-100, Ag-Chem activator and X-77 surfactants were compared alone and in some combinations in one field test (Table 3). A hand gun was used to completely cover the trees with 5 to 8 gal (19 to 30 liters) of spray per tree depending on size. Two tree plots were used except as noted in the results. The trials were conducted in commercial citrus groves, mostly on rough lemon (*C. jambhiri* Lush.) and 'Hamlin' on Carrizo citrange (*C. sinensis* X *Poncirus trifoliata*).

Ethylene (6), defoliation, fruit drop and damage (3) were determined by previously described methods. No statistical analyses were used since many of the mean fruit removal force (FRF) values would be significantly different but of no practical importance.

Results and Discussion

'Hamlin' oranges. When either 5 or 10 ppm Acti-Aid was used with 75 ppm Pik-Off, the fruit on trees sprayed in December were loosened so that they required about 5.0 lb FRF (Table 1). The loosening caused by 150 or 75 ppm Pik-Off alone was not adequate for effective mechanical harvesting. Generally, the FRF should be lowered to about 5 lb for efficient mechanical harvesting. In January and February all treatments caused good fruit loosening. Therefore, the choice of sprays to use on 'Hamlin' oranges in these months depends on cost, and amount of defoliation and rind damage. Fruit damage was considerably less by 75 ppm Pik-Off plus 5 ppm Acti-Aid than by higher levels of either chemical used alone. Defoliation was less than 5% in all trees.

The FRF values reported here are slightly higher than those reported by others who used 10 ppm Acti-Aid and

Table 1. Fruit removal force for 'Hamlin' oranges 5 days after application of Pik-Off alone or in combination sprays.

Treatment[y] ppm	FRF[x] Dec	Jan	Feb
150 Pik-Off	7.8	4.7	5.0
75 Pik-Off	8.4	4.2	4.2
75 Pik-Off + 10 Acti-Aid	4.9	3.8	2.3
75 Pik-Off + 5 Acti-Aid	5.4	5.1	6.2
75 Pik-Off + 5 Acti-Aid + 100 Sweep	5.3	4.7	4.2
Control	18.0	14.7	10.2

[x]Average of 10 fruit from 2 replications.
[y]Contains 0.1% Triton X-100.

[1]This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended.

Acti-Aid plus Sweep in other seasons (4). However, in 1976-77 the FRF resulting from the 75 ppm Pik-Off plus 5 ppm Acti-Aid spray in December and January was as low as that from 10 ppm Acti-Aid (data not presented). Combinations of Pik-Off with 10 ppm Acti-Aid were no better than 10 ppm Acti-Aid alone for loosening 'Hamlin' oranges, but treatments containing 5 ppm Acti-Aid were acceptable.

'Valencia' oranges. Two combinations of Release, Pik-Off and Sweep sprayed on 'Valencia' oranges in 1976 caused good fruit loosening in April (Table 2). Both combinations lowered the FRF from 18.2 to 4.0 lb. This amount of loosening has often been induced in April with Acti-Aid or Release (5, 7). Defoliation was less than 5% and damage to young fruit was slight compared to that caused by other abscission chemicals (3).

Table 2. Fruit removal force for 'Valencia' oranges 5 days after abscission chemical application (Release; Pik-Off; Sweep combinations).

Treatment[z] ppm	FRF[z] April	May	June
75:75:250	3.6	12.2	13.1
125:75:100	4.4	10.4	12.6
250:75:100	—	11.4	10.0
100:100:100	—	8.1	8.9
— 100:200	—	12.2	14.3
— 200:200	—	12.0	12.5
Control	18.2	19.7	18.8

[z]See Table 1.

During May and June, none of the sprays shown in Table 2 lowered the FRF sufficiently for mechanical harvesting. These data show that the combinations containing Pik-Off and Release were no better than single chemical sprays for loosening 'Valencia' oranges.

Combination sprays containing Pik-Off, Acti-Aid and Sweep plus one of several surfactants (Table 3) loosened fruit at another location in 1977. The FRF of the control fruit was lower than normal, probably because of the January freeze (13 vs 18 to 20 lb). Some fruit were damaged by the freeze. Treatments 6 through 9 generally caused good loosening compared to Treatments 1 and 2. Although 150 ppm Pik-Off with 0.1% Triton X-100 plus 0.1% Ag-Chem activator or 0.1% X-77 loosened fruit satisfactorily (Table 4), the amount of fruit damage was more severe than when combination sprays were used. The range of FRF's of fruit from treatments 4 and 5 was 4.5 to 7.5 lb, well within the acceptable range; however, rind damage was excessive. Treatment 3 gave about the same results as 1 and 2.

Table 3. Spray combinations used on 'Valencia' oranges in 1977.

Treatment number	ppm Pik-Off	Acti-Aid	Sweep
1. A → E	150	—	—
2. "	150	—	100
3. "	150		200
4. "	300		100
5. "	300	—	—
6. "	75	5	—
7. "	75	5	100
8. "	75	10	0
9. "	75	10	100
10. "		Control	

A = Without surfactant.
B = With 0.1% Triton X-100.
C = With 0.1% Triton X-100 + 0.1% Ag-Chem Activator.
D = With 0.1% X-77.
E = With 0.1% X-77 + 0.1% Ag-Chem Activator.

Table 4. Fruit Removal Force[z] (lb) 3 days after spray application (Treatments, Table 1).

Treatment number	Surfactant A	B	C	D	E
1.	9.8	5.9	3.2	4.7	9.9
2.	9.6	9.3	5.3	9.5	7.1
6.	8.8	6.1	4.8	5.8	5.7
7.	4.9	3.2	6.4	3.5	3.1
8.	5.6	2.3	6.8	5.4	2.6
9.	6.7	3.3	4.7	6.2	3.9
10.	13.0	13.4	13.2	13.0	13.0

[z]Average of 20 fruit.

The FRF values at 6 days indicate that surfactants increase fruit loosening and that 150 ppm Pik-Off alone or with Sweep (Treatments 1 and 2) did not cause adequate loosening (Table 5). Sweep in some cases prolongs the looseness of the fruit (Treatments 6 and 7). Treatments 8 and 9 lowered the FRF equally; this indicates that 10 ppm Acti-Aid with Pik-Off overrode the effect of Sweep. However, damage to young fruit was excessive in Treatments 8 and 9. Sweep did decrease the amount of defoliation.

Table 5. Fruit Removal Force[z] (lb) 6 days after spray application (Treatments, Table 1).

Treatment number	Surfactant A	B	C	D	E
1.	16.4	12.1	10.2	8.8	14.6
2.	14.7	12.3	11.9	12.5	9.7
6.	12.0	9.1	11.4	5.8	4.4
7.	11.8	4.3	5.8	7.2	3.8
8.	9.9	3.3	5.8	6.3	3.0
9.	13.7	2.2	7.9	4.1	3.7
10.	15.9	15.2	15.9	15.1	15.9

[z]Average of 20 fruit.

Also, if the data in Table 5 are compared with those in Table 4, retightening of the fruit is evident, especially when Pik-Off was used alone. Both Acti-Aid and Sweep prolonged the effectiveness of the combinations sprays.

Ethylene in the internal atmosphere of 'Valencia' oranges from selected treatments in Table 3 was higher after 5 and 7 days when Sweep was part of the combination spray (Fig. 1). Also, Pik-Off caused an early burst of ethylene production. Ethylene data for Treatments 6 and 7 are not presented because of space limitations, but the levels were between those of Treatments 2 and 8.

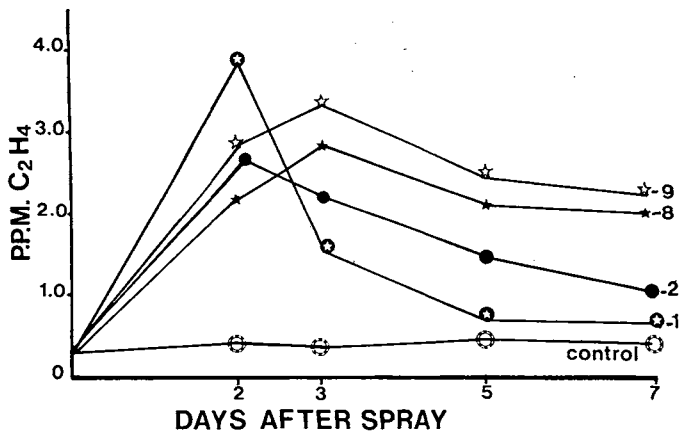

Fig. 1. Ethylene in the internal atmosphere of *'Valencia'* oranges treated with Pik-Off and Pik-Off combinations selected from Table 3.

The data from experiments during the last 3 years suggest that 'Hamlin' oranges are loosened effectively with several individual chemicals or combinations of these chemicals, including Acti-Aid, Release, and Sweep. Also, the data show that no advantage was gained by Release and Pik-Off combinations. Acti-Aid is the only chemical cleared for loosening citrus fruit. Release, Pik-Off and Sweep have been cleared for experimental use only. The results presented here show that combinations of Pik-Off, Acti-Aid plus Sweep with surfactants may be just as efficient as other combination sprays of Acti-Aid, Release and Sweep (7). During the 'nonresponsive' period in May or early June, the Pik-Off combinations were not effective but other combinations also gave variable results. Fruit with slight cold damage is an exception. By lowering the amount of Acti-Aid and Pik-Off in the combinations with Sweep less severe fruit damage and less defoliation result compared to higher concns of single chemicals.

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SHAKER REMOVAL METHODS AFFECT 'VALENCIA' ORANGE YIELD[1,2]

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Abstract. **During the 1976 'Valencia' orange harvest season, 5 fruit removal methods were evaluated at 3 harvest dates for their effectiveness in loosening mature fruit and for their effect on subsequent fruit yields. The abscission chemical RELEASE[3] (5-chloro-3-methyl-4-nitro-1H-pyrazole) was used in some cases. Fruit removal force was reduced with RELEASE, but effectivness of the material decreased when rain occurrd shortly after application. Fruit yields were reduced from 4 to 36% with the greater reductions occurring later in the season. Fruit yields were reduced the least in trees when sprayed with RELEASE and harvested with limb shakers mounted on a self-propelled carriage. A comparable yield reduction of 12% occurred with the shaker catchframe plus RELEASE and the air shaker plus RELEASE in a May 11 test. However, the air shaker reducd yield about 25% more in a May 20 test. Less reduction in yield occurred when RELEASE was used in comparison to no use of the chemical in shaker catchframe tests conducted May 11 and May 20.**

Several mechanical shaker systems have been developed and demonstrated for removing fruit from citrus trees (2, 3, 4). Acceptance of these methods by the industry has been limited. The predominant reason has been their poor efficiency in the selective removal of mature 'Valencia' oranges without excessive removal of the next year's young fruit. The abscission chemical RELEASE, manufactured by Abbott Laboratories, showed excellent potential for improving these removal methods by selectively loosening only the mature fruit (5).

With 'Valencia', the efficiency of mechanical shakers in combination with an abscission chemical depends primarily on 1) correct application of the chemical to obtain uniformity of mature fruit loosening, 2) type of shaker and its operation, and 3) stage of young fruit development. The effectiveness of abscission chemicals is dependent on weather and on the condition of the trees at the time of application. During the 'Valencia' season there is usually a period when the mature fruit becomes less responsive to the abscission chemical and a higher than normal application rate is required (5).

The objective of the research reported in this paper was to evaluate several fruit removal methods, under simulated commercial conditions, for their relative effectiveness in the selective removal of mature 'Valencia' oranges. Factors evaluated were the degree of fruit loosening and the effect of removal methods on subsequent fruit yield. This report includes the first year's (1976) results of an anticipated 4-year research program.

Materials and Methods

The experiment was established in a 'Valencia' orange grove leased by the Florida Department of Citrus (FDOC) and located near the Agricultural Research and Education Center (AREC) Lake Alfred. The grove was situated on slightly rolling terrain with trees on rough lemon rootstock, spaced 25 ft x 25 ft and ranging in height from 20 ft to 25 ft.

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[3]Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.