Diaprepes abbreviatus[1]: Fate of Diflubenzuron and Effect on Nontarget Pests and Beneficial Species after Application to Citrus for Weevil Control[2,3]

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ABSTRACT

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When IGR diflubenzuron, 25W, was applied aerially to a commercial citrus grove for control of *Diaprepes abbreviatus* (L.), residues in ppm on fruit harvested 27 days after the 6th application (350 g AI/ha/application) were: unwashed fruit, 0.34; washed fruit, 0.11; dried pulp, 0.26; peel frit, 0.31; chopped peel, 0.12; and oil, 20.55. No detectable residue (<0.05 ppm) of diflubenzuron was found in finisher pulp, fruit juice, pressed liquor, molasses, prewash or afterwash water, and emulsion water fractions. No residue (<0.05 ppm) of 4-chlorophenylurea or 4-chloroaniline was found in any of the citrus fractions. Also, the total sealed brood in colonies of honey bees, *Apis mellifera* L., from the check and sprayed groves was not significantly different at 7 months. No detectable residue (<0.05 ppm) of diflubenzuron, 4-chlorophenylurea, or 4-chloroaniline was found in the honey obtained after 8 aerial sprays. Populations of nontarget citrus pests and beneficial species apparently were not affected by the spray program.

A sugarcane rootstalk borer weevil, *Diaprepes abbreviatus* L., is an important pest of sugarcane and citrus in the West Indies. The weevil was found in central Florida in 1964. By 1979, the weevil was established on 4000 ha of citrus (total citrus in Florida 324,000 ha) but was not found on sugarcane (total sugarcane in Florida 132,000 ha). The USDA is attempting to reduce spread of *D. abbreviatus* in Florida through population suppression and to minimize future spread by plant inspection and by applying pesticides to plants prior to export from infested areas.

Recently, when the insect growth regulator (IGR) diflubenzuron was applied to citrus groves by air, weevil egg hatch was reduced (Schroeder et al. 1976). Also, the spray oil FC435-66 (Simanton and Trammell 1966), recommended for control of citrus scale insects and disease (Anon. 1977), was observed to have an adverse effect on the physical attachment of weevil eggs (Schroeder et al. 1977). The combination of the IGR plus oil, therefore, might provide a method for *D. abbreviatus* population suppression (Schroeder and Sutton 1978). However, residue data and data concerning the impact on nontarget pests and beneficial species were needed to facilitate use of diflubenzuron on citrus. Therefore, we selected commercial citrus groves in the weevil area and applied diflubenzuron plus oil in a program for suppression of the weevil population. Then, we harvested and processed the fruit and determined residues of diflubenzuron, 4 chlorophylurea, or chloroaniline in the citrus products. Residue data and data concerning effects of application on nontarget and beneficial species in the groves are reported here.

Materials and Methods

The citrus grove was 4 ha, 15 years old, and contained 173 trees/ha (7.6 m between trees and rows). Average tree height was 4.0 m. The grove was irrigated, disced, and fertilized by a commercial grove management service. It was sprayed aerially with diflubenzuron at 350 g AI/ha, on May 6, June 8, July 5, Aug. 10, Sept. 7, Oct. 22, Nov. 22, and Dec. 14, 1977. The spray plane had 4 Micronair® rotary atomizers; the pressure in the system was 2.1 kg/cm² and the volume applied/ha was 47 liters. Copper (Kocide 101®) was included in the 1st spray on May 6 (rate of 1892 g/ha) for control of melanose, *Diaporthe citri* Wolf. Florida citrus oil FC 435–66 was included in the July, August, September, and October sprays (50/50 oil-water ratio) for control of greasy spot, *Mycosphaerella citri* Whiteside, as a scalicide, and for weevil control. All sprays were applied in the early morning to minimize drift.

The check grove also was 4 ha, 15 years old, and had 173 trees/ha. This grove too was disced and fertilized by a contract management service at the request of the USDA (i.e., the check received ca. the same cultural practices as the sprayed grove).

Honey bees, *Apis mellifera* L., are active during bloom period (April–June), so we placed 2 hives in the sprayed grove and 2 hives in an adjacent grove and compared brood development. Hives in the sprayed grove were covered with plastic when spray was applied. The brood chambers were 24×41×51 cm and contained 10 frames each. An excluder and supers were added during the season. The sealed brood was estimated 12 times from May to November by placing a grid over each frame from the brood chamber and counting squares in the grid.

Residue Sample

Samples of honey were taken from the 4 hives after spraying on Dec. 14 and were examined for diflubenzuron, 4-chlorophenylurea, and 4-chloroaniline residues. Also harvest fruit (check 411 kg, treated 436 kg) taken 27 days after the 6th application were fractionated at the Institute of Food and Agricultural Science, University of Florida, Lake Alfred, FL, and subjected to a processing program developed at the Agricultural Research and Education Center, Lake Alfred, to duplicate industry practice with variables under control. This facility

[1] Coleoptera: Curculionidae.

[2] Received for publication Jan. 30, 1980.

[3] This paper reports the results of research only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended. Also, mention of a commercial or proprietary product does not constitute endorsement by the USDA.

Table 1.—Honey bee sealed brood in hives maintained in the IGR-sprayed grove and check grove, 1977.

	$\bar{x}$ Sealed brood/hive[a]							
	May	June	July	Aug.	Sept.	Oct.	Nov.	Seasonal $\bar{x}$
Sprayed (IGR)	15009a	14449a	8460a	12991a	16819a	15609a	9097a	13205a
Unsprayed	13628a	9000b	11968a	13970a	15796a	17369a	11990a	13389a

[a] Values in each column not sharing a common letter are different at the 5% level student "t" test.

complies with all requirements of the Food and Drug Administration and the Environmental Protection Agency and processing conformed completely with industry practice for processed citrus products. Samples of whole fruit (washed and unwashed), chopped peel, frits, finisher pulp, dried citrus pulp, fruit juice, oil, pressed liquor, molasses, emulsion water, prewash and afterwash water from the facility were examined for diflubenzuron, 4-chlorophenylurea, and 4-chloroaniline residues. Residue analysis was performed by the Thompson-Hayward Chemical Company, Kansas City, KS, using the methods of Rabenort et al. (1978).

Citrus Pest Leaf Sample

Populations of leaf pests were sampled from sprayed and check groves on May 4, July 1, Aug. 18, Sept. 22, Dec. 6, 1977, and once in October 1978. A Sample consisted of 50 leaves/tree, randomly selected from 5 trees and the number of mature female scale insects on all 250 leaves/sample was recorded by species. Phytophagous mites were counted on 125 leaves from the sample and identified by species. Predacious, fungus, and scavenger mites were counted on 125 leaves from the sample but were not identified to species.

Results and Discussion

The average number of sealed brood in check and treated beehives was not significantly different ($P > 0.05$) for the spray period except in June, when sealed brood in treated hives was significantly more (Table 1). The application of diflubenzuron on citrus apparently had no significant effect on bee brood development.

No detectable residue (<0.05 ppm) of diflubenzuron, 4-chlorophenylurea, or 4-chloroaniline was found in the honey. Diflubenzuron residue was found in unwashed fruit, washed fruit, dried pulp, peel frit, chopped peel, and oil (0.34, 0.11, 0.26, 0.31, 0.12, and 20.55 ppm, respectively). No detectable residue (<0.05 ppm) of diflubenzuron was found in the finisher pulp, fruit juice, pressed liquor, molasses, prewash or afterwash water, and emulsion water fractions. No detectable residue (<0.05 ppm) of 4-chlorophenylurea or 4-chloroaniline was found in the citrus fractions, nor in the prewash or afterwash water. On the basis of the results from the extracted peel and oil, the majority of the diflubenzuron residue found in the peel was actually in the oil.

Nontarget and beneficial species were monitored to determine whether the IGR-oil spray had an effect on the natural balance in the groves. In the 1977 leaf sample, the average number of citrus rust mites, *Phyllocoptruta oleivora* (Ashmead), per leaf between check and treated groves was not significantly different ($P > 0.05$). There were 0.02 and 0.01 mites/leaf for check and treated groves, respectively. There were significantly ($P < 0.05$) more Texas citrus mites, *Eutetranychus banksi* (McGregor), on check than on treated leaves (0.04 and 0 mites/leaf, respectively). The predacious, fungus and scavenger mite populations were not significantly different ($P > 0.05$). There were 1.71 and 0.77 mites/leaf for check and treated leaves, respectively. Scale insects were not observed in the 1977 leaf samples.

The citrus rust mite, Texas citrus mite, and predacious, fungus, and scavenger mite populations were unchanged in the 1978 sample. The only scale insect observed was the Glover scale, *Lepidosaphes gloveri* (Packard). There were 0.04 and 0 scales/leaf for check and treated groves, respectively.

Although the population of citrus leaf pests was very low in 1977–78, there was no indication that the IGR-oil spray program increased the damage caused by these pests through removal of their predators or parasites.

Acknowledgment

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REFERENCES CITED

Anonymous. 1977. Florida citrus spray and dust schedule 1977. Fla. Coop. Ext. Serv. Circ. 393-B: 12 pp.

Rabenort, B., P. C. deWilde, F. G. deBoer, P. K. Korver, S. J. DiPrima, and R. D. Cannizzaro. 1978. Diflubenzuron. pp. 57–72. *In* G. Zweig and J. Sherma [eds.], Analytical Methods for Pesticides and Plant Growth Regulators. Vol. X. Academic Press, New York, N.Y.

Schroeder, W. J., and R. A. Sutton. 1978. *Diaprepes abbreviatus*: suppression of reproductive potential on citrus with an insect growth regulator plus spray oil. J. Econ. Entomol. 71:69–70.

Schroeder, W. J., J. B. Beavers, R. A. Sutton, and A. G. Selhime. 1976. Ovicidal effect of Thompson-Hayward TH-6040 in *Diaprepes abbreviatus* on citrus in Florida. Ibid. 69:780–2.

Schroeder, W. J., R. A. Sutton, and A. G. Selhime. 1977. Spray oil effects on *Diaprepes abbreviatus* on citrus in Florida. Ibid. 70:623–4.

Simanton, W. A., and K. Trammell. 1966. Recommended specifications for citrus spray oils in Florida. Proc. Fla. State Hortic. Soc. 79:26–30.

Efficacy and Persiste
for Preventive an

U. EUGENE BRADY, C.
Departm

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registration of lindane, this stu
to compare the efficacy and di
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Methods and

Insecticides

Candidate insecticides inclu
chlorpyrifos (Dursban® 4EC),
(Reldan® 4EC). All final sp
water and were applied with
sprayer.

Preventive Control

In the 1975 study, 0.5% lin
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Field bioassays were initiat
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press) and will be only briefly
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were taken from midbole of

[1] Coleoptera: Scolytidae.

[2] This work was funded in part by a U
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grant No. 516-15-71. The findings, opinion
authors and not necessarily those of the US
[3] Received for publication Feb. 11, 19