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EFFECT OF DIFLUBENZURON ON FOUR SPECIES OF WEEVILS ATTACKING CITRUS IN FLORIDA^{1,2}

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ABSTRACT

Diflubenzuron (*N*-[[4-(4-chlorophenyl)amino]carbonyl]-2,6-difluorobenzamide), an insect growth regulator, was highly effective in reducing the reproductive potential of 4 species of weevils, *Pachnaeus litus* (Germar), *P. opalus* (Olivier), *Artipus floridanus* Horn, and *Diaprepes abbreviatus* (L.), that attack citrus in Florida. Egg hatch was significantly reduced when adult weevils were exposed to citrus foliage treated at rates of 0.15 and 0.30 g AI/liter of water.

Previous tests at the Citrus Root Weevil Laboratory, Plymouth, FL, indicated that diflubenzuron (*N*-[[4-(4-chlorophenyl)amino]carbonyl]-2,6-difluorobenzamide), an insect growth regulator, significantly reduced the reproductive potential of *Diaprepes abbreviatus* (L.) when applied to citrus foliage (Schroeder et al. 1976). Normally after the adult weevils oviposit in the tree canopy, the neonate larvae enter the soil where they feed on the roots, leading to host decline and reduced yield. The adult weevils are also foliage feeders and cause a characteristic notching of leaves that is of secondary importance to mature trees.

Diaprepes abbreviatus was first found in central Florida in 1964 (Woodruff 1964) and presently is found in ca. 2000 ha of citrus. When the adults of this species feed on foliage treated with diflubenzuron, egg hatch is reduced. The objective of this study was to determine if the reproductive potential of 3 other biologically similar species of weevils that also attack citrus in Florida would be affected by feeding on treated citrus foliage. These other species were *Pachnaeus litus* (Germar), *P. opalus* (Olivier), and *Artipus floridanus* Horn.

METHODS AND MATERIALS

The adult weevils tested were collected from indigenous field infestations in Florida. Citrus leaves used in the bioassay were taken from 2 trees (ca. 2 m tall) each sprayed to runoff with a water suspension containing 0.15 or 0.30 g diflubenzuron (AI)/liter. Adult weevils (5♀, 2♂) of each species were confined on leaves from the treated trees in 3.8 x 8.9-cm plastic containers (5 replicates/treatment) and held at ambient laboratory temperature (ca. 26 C) until all weevils were dead. An 8.9-cm-diam disc of filter paper in the bottom of the container absorbed excess moisture; the con-

¹Coleoptera: Curculionidae.

²This paper reports the results of research only. Mention of a pesticide does not constitute a recommendation by the U.S. Department of Agriculture nor does it imply registration under FIFRA, as amended.

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TABLE 1. PERCENTAGE REDUCTION IN HATCH OF EGGS FROM WEEVILS FEEDING ON CITRUS FOLIAGE TREATED WITH DIFLUBENZURON AT RATES OF 0.15 AND 0.30 g AI/LITER.

Species	Treatment rate g AI/liter	Total no. eggs	% Reduction in egg hatch at indicated days posttreatment*				
			4	7	11	14	18
<i>Pachneus litus</i>	0.15	573	40 (391)**	79 (604)	100 (156)	100 (68)	—
	0.30	1115	54	91	100	100	100
	0.15	316	56 (549)	85 (25)	—	—	—
<i>P. opalus</i>	0.30	642	71	34	100	—	—
	0.15	1353	NS† (523)	38 (220)	77 (256)	61 (69)	100 (95)
<i>Artipus floridanus</i>	0.30	2558	87	100	100	100	100
<i>Diaprepes abbreviatus</i> (Standard)	0.15	2503	62 (1663)	100 (927)	100 (230)	100 (20)	100 (17)
	0.30	2755	62	100	100	100	100

*Egg hatch significantly reduced by treatment ($P < 0.01$, X^2 test). Percent reduction determined by Abbott's formula.

**Numbers in parentheses indicate no. of corresponding control eggs hatching.

†NS = reduction in egg hatch not significant.

— = No eggs obtained.

TABLE 2. PERCENTAGE REDUCTION IN HATCH OF EGGS FROM WEEVILS PLACED ON CITRUS FOLIAGE 11 DAYS POSTTREATED WITH DIFLUBENZURON AT RATES OF 0.15 AND 0.30 g AI/LITER.

Species	Treatment rate g AI/liter	Total no. eggs	% Reduction in egg hatch at indicated days posttreatment*				
			14	18	21	25	28
<i>Pachneus litus</i>	0.15	439	33 (202)**	49 (20)	NS	—	—
	0.30	525	NS†	100	100	60	71
<i>P. opalus</i>	0.15	143	NS (68)	—	—	—	—
	0.30	70	35	—	—	—	—
<i>Artipus floridanus</i>	0.15	1085	NS (324)	NS (422)	NS (19)	80 (157)	54 (56)
	0.30	1152	40	96	100	100	92
<i>Diaprepes abbreviatus</i> (Standard)	0.15	4202	NS (144)	96 (1937)	100 (16)	100 (889)	41 (230)
	0.30	3668	NS	100	100	100	100

*Egg hatch significantly reduced by treatment ($P < 0.01$, χ^2 test). Percent reduction determined by Abbott's formula.

**Numbers in parentheses indicate no. of corresponding control eggs hatching.

†NS = reduction in egg hatch not significant.

— = No eggs obtained.

tainers were provided with wax paper strips (2 x 6 cm) as artificial oviposition sites. Egg masses were removed 2X a week when fresh leaves from the treated trees and new wax paper strips were placed in each container. Because eggs of the 4 weevil species normally hatch within ca. 7 days, they were held in 25 dram plastic vials a minimum of 10 days. Hatch was then determined by counting neonate larvae and unhatched eggs. Since diflubenzuron was effective in significantly reducing the reproductive potential of *D. abbreviatus* in earlier tests, we included this species in these tests for a treatment comparison. Weevils of all 4 species were confined on untreated leaves as controls (5 reps/species). The residual activity of diflubenzuron was evaluated by repeating the test at 11 days posttreatment.

Because egg hatch from the control weevils varied during the test, the percentage reduction in egg hatch was determined by Abbott's formula. Chi-square analysis was used to determine if significant reduction in egg hatch occurred at each counting date posttreatment.

RESULTS AND DISCUSSION

The effect of the insect growth regulator on *D. abbreviatus* was as previously reported by Schroeder et al. (1976): at 7 days posttreatment (both rates), there was a 100% reduction in egg hatch (Table 1). Egg hatch for *P. litus* and *A. floridanus* was also significantly reduced by both treatments though the lower rate was less effective against *A. floridanus*. A significant reduction in egg hatch also occurred in *P. opalus*. Adult *P. opalus* exposed to both treated and untreated foliage survived only ca. 1 week, perhaps because the adults have a short lifespan or because these weevils were aged when collected.

In a different test when other weevils were placed on foliage at 11 days posttreatment, significant reductions in egg hatch generally did not occur until 7 days later (Table 2). This indicated a slight loss in the biological activity of diflubenzuron in the adult weevils.

The percentage of control eggs hatching for each species exposed at 0 and 11 days respectively was: *P. litus* 54 and 40%; *P. opalus* 78 and 61%; *A. floridanus* 89 and 86%; and *D. abbreviatus* 40 and 39%.

Symptoms produced in each species by diflubenzuron were the same as reported earlier for *D. abbreviatus* (Schroeder et al. 1976), i.e. embryonic development was inhibited and the eggs failed to hatch.

Diflubenzuron therefore has a high degree of biological activity in the 4 weevil species tested and may have potential as a control for this economically important weevil complex in Florida citrus.

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