Diaprepes abbreviatus:[1] Suppression of Reproductive Potential on Citrus with an Insect Growth Regulator Plus Spray Oil[2,3]

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ABSTRACT

The reproductive potential of *Diaprepes abbreviatus* (L.) was significantly reduced by aerial applications of diflubenzuron (*N*-[[(4-chlorophenyl)amino]carbonyl]-2,-6-difluorobenzamide), 25W, plus spray oil. The diflubenzuron reduced the hatch of eggs, and the oil caused eggs to become detached from foliage. As a result, viable eggs were reduced 95, 97, 95, and 95%, respectively, for 4 consecutive wk posttreatment. A spray volume of 47 liter/ha (350 g diflubenzuron/ha in 50/50 spray oil plus water) applied by air to a bearing citrus grove was more effective than a spray volume of 9 liter/ha.

At present, there are no recommended methods for control of *Diaprepes abbreviatus* (L.) on citrus. However, the insect growth regulator (IGR) diflubenzuron (Thompson-Hayward TH-6040; *N*-[[(4-chlorophenyl)amino]-carbonyl]-2,6-difluorobenzamide), when applied to a citrus grove by air, was found to reduce hatch of weevil eggs (Schroeder et al. 1976). Also, the spray oil FC435-66 (Simanton and Trammell 1966) recommended for control of citrus scale insects and disease (Anon. 1976) was observed to have an adverse effect on the physical attachment of weevil eggs. The experiment reported here was an attempt by the Citrus Root Weevil Laboratory to develop an acceptable spray formulation of diflubenzuron 25W + spray oil for aerial application and to study the combined effect on weevil reproduction.

Methods and Materials.—The spray formulations were applied with a Piper Pawnee Brave aircraft to a 4-ha citrus grove located near Plymouth, FL. The grove was 17 yr old and was planted with 173 trees/ha (7.6 m between trees and rows); avg tree height, 4.5 m. The grove was fertilized twice during 1976 and disced as necessary to reduce weed growth. Treatment plots consisted of 3 rows in the grove. Three rows were left unsprayed as a buffer strip. Applications were made only in early morning, when the air was calm.

Two volumes of spray were applied, 47 and 9 liter/ha. The volume of 47 liter/ha was delivered with 60 D8-45 nozzles on the spraybOOm; the spraying system was pressurized at 5.27 kg/cm^2. The volume of 9.4 liter/ha was delivered with 4 Beecomist® nozzles fitted with 100-μm perforated spinning sleeves; the pressure in the system was 2.1 kg/cm^2.

The 47 liter/ha spray formulations were applied as follows (3 rows/treatment): Apr. 20—175, 350, or 700 g diflubenzuron/ha formulated in 50/50 spray oil + water and 700 g diflubenzuron/ha formulated in water with 50 ml of Activate®/liter; July 14—87.5, 175, or 350 g diflubenzuron/ha formulated in 50/50 spray oil + water. On Aug. 17, the entire grove was treated with 350 g diflubenzuron/ha formulated in 50/50 spray oil + water.

The 9 liter/ha spray formulations were applied as follows (3 rows/treatment): June 9—87.5, 175, or 350 g diflubenzuron/ha formulated in 50/50 spray oil + water; June 23—35, 70, or 140 g diflubenzuron/ha formulated in spray oil.

The effect of diflubenzuron was determined by collecting adult weevils from untreated citrus and caging them (5♀ and 2♂/cage) on treated trees (4 cages/treatment). The cages were ca. 20 cm diam and 50 cm long. Weevils were placed on treated foliage several h after the aerial treatment and weekly thereafter for as long as 5 wk. After each 1-wk exposure, foliage with eggs attached was removed and held in the laboratory at 27°±3°C for a minimum of 7 days. Hatch was determined by counting neonate larvae and unhatched eggs. Controls were weevils caged on foliage in an untreated grove. Because hatch of eggs from control weevils varied during the test, the percentage reduction was determined as:

$$\frac{\%\text{ hatch in controls} - \%\text{ hatch in treatment}}{\%\text{ hatch in controls}} \times 100.$$

Since the number of eggs recovered from oil-treated foliage was less than the number recovered from untreated foliage, the effect of spray oil on viable eggs was determined by exposing 5 potted calamondin trees, *Citrus reticulata* var. *austera* × *Fortunella* sp. Swing., 1.5 m high in the citrus grove prior to the Aug. 17 application of spray. The potted trees were caged (cage size—0.6×0.6×1.35 m) after application, and 10♀ and 3♂ weevils were placed in each cage. An equivalent number of weevils caged on each of 5 caged, unsprayed trees served as checks. The number of eggs on sprayed and unsprayed trees was determined each week, and the loss of oviposited eggs was attributed to the effect of oil.

The percentage reduction in the reproductive potential of *D. abbreviatus* in the sprayed grove (Aug. 17 spray) was estimated as:

$$100 - \frac{(100 - \%\text{ loss of oviposited eggs})}{(100 - \%\text{ reduction in egg hatch})} \over 100$$

Results and Discussion.—Rainfall for Apr., May,

[1] Coleoptera: Curculionidae.

[2] Received for publication May 21, 1977.

[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 a proprietary product does not constitute an endorsement by the USDA.

Table 1.—Percentage reduction in hatch of eggs from weevils feeding on citrus bearing a residue of diflubenzuron sprayed in a volume of 47 liter/ha, Plymouth, FL, 1976.

Treatment g AI/ha	No. eggs in thousands	% reduction in egg hatch when weevils were introduced into the grove at time of treatment and at indicated wk posttreatment[a]					
		0	1	2	3	4	5
		Apr. 20					
175.0	9.2	97	—[b]	78	71	70	74
350.0	8.4	97	—	78	89	87	79
700.0	8.9	100	—	62	89	85	79
700 + Activate	6.6	94	—	97	42	69	—
		July 14					
87.5	6.2	45	64	87	66	—	—
175.0	5.2	79	85	67	39	—	—
350.0	7.6	88	73	70	56	—	—
		Aug. 17					
350.0	8.3	65	71	51	30	—	—

[a] Egg hatch significantly reduced by treatment ($P<0.01$, χ^2 test).
[b] No weevils introduced to grove.

June, July, and Aug. totaled 4.24, 15.65, 19.43, 13.97, and 24.33 cm, respectively. Precipitation usually occurred in the form of an afternoon shower. The grove had new growth flushes in May after fertilizer was applied and rainfall increased. A 2nd flush of growth occurred in late Aug.

Table 2.—Percentage reduction in hatch of eggs from weevils feeding on citrus bearing a residue of diflubenzuron sprayed in a volume of 9.4 liter/ha, Plymouth, FL, 1976.

Treatment g AI/ha	No. eggs in thousands	% reduction in egg hatch when weevils were introduced into the grove at time of treatment and at indicated wk posttreatment[a]				
		1	2	3	4	5
		June 9				
87.5	7.9	—[b]	36	72	5	NS[c]
175.0	10.1	—	75	65	9	NS
350.0	9.5	—	23	56	28	30
		June 23				
35.0	4.6	NS	30	NS	—	—
70.0	2.5	23	14	NS	—	—
140.0	2.8	28	17	NS	—	—

[a] Egg hatch significantly reduced by treatment ($P<0.01$, χ^2 test).
[b] No weevils introduced into the grove.
[c] NS = reduction in egg hatch not significant.

Table 3.—Percentage reduction in attached eggs and in hatch and the combined effect on weevil reproduction in the grove sprayed (47 liter/ha) Aug. 17, with diflubenzuron (350 g/ha) in 50/50 spray oil + water, Plymouth, FL.

Wk post-treatment	Total eggs attached		% reduction		
	On 5 treated trees	On 5 check trees	In attached eggs	In egg hatch	In reproductive potential
1	1360	9981	86	65	95
2	680	6987	91	71	97
3	513	4945	90	51	95
4	215	3145	93	30	95

All rates of diflubenzuron applied in high volume (47 liter/ha) by air on mature citrus had a significant effect on the hatch of *D. abbreviatus* eggs (Table 1). The formulation containing 350 g/diflubenzuron/ha appeared to give the best results. Diflubenzuron applied in low volume (9.4 liter/ha) gave variable results (Table 2), probably because of inadequate coverage.

The number of eggs on treated and untreated trees differed significantly ($P<0.01$) (Table 3), but mortality of weevils on treated and untreated trees was not significantly different ($P>0.05$). The data confirmed counts made following the Apr. and July sprays, i.e., an 86% loss of eggs occurred with no increase in weevil mortality. The loss of eggs was caused by the presence of oil on the leaf surface.

The combined effect of oil (reduction in attached eggs) and diflubenzuron (reduction in egg hatch) is expressed as loss in reproductive potential in Table 3. The total loss was >90% the 4 wk following the Aug. 17 spray application.

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