SUPPRESSION OF CITRUS ROOT WEEVIL EGG HATCH BY DIFLUBENZURON FOLIAR RESIDUES

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Previous studies with diflubenzuron (AI of Micromite®, Dimilin® [Cromton Corporation, Greenwich, CT 06831] and Thompson-Hayward TH-6040) revealed inhibition of embryogenesis in eggs of several citrus root weevils fed on treated foliage and provided folded wax paper strips as oviposition sites (Schroeder et al. 1976; Lovestrand & Beavers 1980). In addition, Schroeder et al. (1976) found that foliar sprays of diflubenzuron applied at rates of 56.6 g and 113.2 g (AI)/378 liters of water with a high-pressure handgun sprayer reduced egg hatch for 10 days. An aerial application delivering 283 g (AI) + the extender Pinolene® in 45 l/A was effective for at least 26 days against *Diaprepes abbreviatus* (L.). Lovestrand and Beavers (1980) also obtained significant reduction of egg hatch of *D. abbreviatus*, *Pachnaeus litus* (Germar) and *Artipus floridanus* Horn for 28 days after treatment with handgun-applied foliar sprays equivalent in rates to those used by Schroeder et al. in 1976.

By eliminating wax paper strips as oviposition sites, Schroeder (1996) limited the effect of diflubenzuron to residues present on the leaf surfaces used for oviposition. This indicated that direct egg mass contact with diflubenzuron was an additional mode of action. The two rates evaluated by Schroeder (1976, 1996), 142 g and 284 g (AI)/984 l of a 1% oil emulsion, were the same used by Lovestrand and Beavers' 1980 rate, which were equivalent to 1× and 2× the 568 g rate of Micromite 25W (142 g AI) recommended for rust mite control (Knapp 2001).

Schroeder (1996) harvested field-sprayed leaves, paper-clipped them together to form an oviposition site, and placed treated and untreated leaf-pairs in cages containing lab-reared ovipositing female adult *D. abbreviatus*. The 1× and 2× rates resulted in reductions of 77% and 86% in egg hatch for all time periods with no significant differences between rates.

Our research, conducted at Ft. Pierce, FL, and reported here, compares the effect of residues on egg hatch reduction from aqueous and 0.5% oil emulsion sprays containing 568 g rate of Micromite 25W.

The 1996 Test. A total of twenty shoots bearing mature flush were selected and tagged on nine 6-year-old 'Ruby Red' grapefruit trees. On each twig, 4 distal leaves that could be paired and held together with a paper clip were selected. These provided juxtaposed plant surfaces that were suitable for oviposition. The 2 leaf-pairs were isolated on the twig by removing other leaves to facilitate caging of the oviposition site. Nine hundred and fifty liters of aqueous and 0.5% oil emulsion sprays (FC 435-66) containing 568 g of Micromite 25W were prepared. These materials were applied as foliar sprays to "run-off" to 3 trees per treatment. Three unsprayed trees served as controls.

After spray application, the leaves were allowed to dry. The paired leaves on 4 terminals were paper-clipped together and each terminal inserted into a 5.1 cm diameter, 15.2 cm long cylindrical mesh cage on the tree. Two male and 4 female field-collected *D. abbreviatus* adults were placed in each cage with a sprig of tender foliage as food. Fresh, tender foliage was provided as food every other day. Adults were removed from the cages on the 7th day post-treatment. Cages were left on the tree an additional 7 days to protect the egg masses from predation. Cages and leaf-pairs were collected on the 14th day and brought to the lab where egg masses were exposed and examined under a stereomicroscope to determine their viability. Eggs with embryos, empty eggs and neonates were counted. This same procedure was repeated with fresh weevils on the 7th, 14th, 21st and 28th day after spraying to provide data on the activity of residues on egg hatch over time. The test was terminated after 5 weeks. Rainfall was recorded during the test (Table 1).

There were 116, 1267 and 4054 neonates recovered from leaves harboring eggs treated with Micromite 25W and oil emulsion, aqueous mixture of Micromite 25W, and untreated control, respectively. This is an average of 98% and 70% reduction in egg hatch for all time periods with significant differences between treatments (Table 2).

TABLE 1. RAINFALL RECORDED (IN CM) DURING MICROMITE 25W TRIALS AT FT. PIERCE, FL.

	1996	1997
Treatment applied:	30 May	21 May
21-31 May	0	1.39
31 May	2.21	0
1-8 Jun	2.54	2.57
9-16 Jun	2.18	13.18
17-24 Jun	7.54	3.66

Gauge checked 0800 h daily.

TABLE 2. PERCENT REDUCTION IN HATCH OF *D. ABBREVIATUS* EGGS LAID ON MICROMITE 25W-TREATED FOLIAGE.

Treatment	Rate per 950 l	% Reduction in egg hatch at indicated days post treatment[z]					Average % reduction
		+7	+14	+21	+28	+35	
Micromite 25W+	568 g						
FC 435-66 Oil	4.75 l	99 c	100 c	98 c	94 b	99 c	98 c
Micromite 25W	568 g	55 b	74 b	72 b	75 b	71 b	70 b
Untreated	0	2 a	14 a	3 a	6 a	4 a	6 a

[z]Percent separation within columns by Duncan's Multiple Range Test, 1% level.

TABLE 3. PERCENT REDUCTION IN HATCH OF *P. LITUS* EGGS LAID ON MICROMITE 25W-TREATED FOLIAGE.

Treatment	Rate per 950 l	% Reduction in egg hatch at indicated days post treatment[z]				Average % reduction
		+7	+14	+21	+28	
Micromite 25W+	568 g					
FC 435-66 Oil	4.75 l	70 b	100 b	50 b	100 b	80 b
Micromite 25W	568 g	25 a	39 ab	59 b	78 ab	50 a
Untreated	0	2 a	56 a	2 a	28 a	22 a

[z]Percent separation within columns by Duncan's Multiple Range Test, 5% level.

Schroeder (1996) found no difference between two Micromite 25W treatments, viz., 568 and 1136 g of Micromite 25W in 1% oil emulsion sprays. However, we found that the addition of 0.5% oil emulsion to the Micromite 25W treatment significantly reduced egg hatch compared to the aqueous spray.

The 1997 Test. Materials and methods in this experiment differed in 3 respects from the 1996 test: (1) the weevil was *P. litus*, (2) 17-year-old "Navel" orange trees were used, and (3) the test was terminated after 28 days.

The results of the test reveal that there were 110, 747 and 1167 neonates found on leaves treated with Micromite 25W oil emulsion, aqueous and no spray, respectively. This is an average of 80% and 50% reduction for all time periods with significant differences among treatments (Table 3).

While Lovestrand and Beavers (1980) compared 568 and 1136 g of Micromite 25W in aqueous sprays and found that egg hatch was significantly reduced by both treatments, we found that 568 g in 0.5% oil emulsion treatment was equivalent in its impact on the weevils to their low rate of 568 g. Our aqueous spray residue, however, performed poorly compared to their similar aqueous treatment, perhaps partly due to the rainfall that occurred during our test (Table 1). However, the oil component of our emulsion spray apparently improved residue retention and contributed to its acceptable performance.

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SUMMARY

Residues of the 568 g Micromite 25W spray rate were less effective in reducing egg hatch of *Pachnaeus litus* than the same rate of Micromite 25W fed by Lovestrand and Beavers (1980) to the same insect, but the addition of oil in our studies improved the effectiveness of the foliar residues in the absence of feeding.

Furthermore, Micromite 25W in the 0.5% oil emulsion was equal in efficacy to Micromite 25W in 1% oil emulsion (Schroeder 1996) in reducing *Diaprepes abbreviatus* egg hatch and would provide the grower equivalent performance for less cost.

There is no reduction in oviposition attempts or hatchability because of oil residue (Schroeder & Green 1983).

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