EVALUATION OF FOLIAR SPRAYS FOR CONTROL OF ADULT *DIAPREPES ABBREVIATUS* L. ON FLORIDA CITRUS

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ABSTRACT

Field tests with 13 compounds applied by a jeep-mounted airblast sprayer to caged adult *D. abbreviatus* on citrus indicated that acephate, carbofuran, Carzol, Volaton and Monitor were superior to the carbaryl standard. A subsequent aerial test with acephate, carbofuran, Carzol, ULV malathion and carbaryl indicated that carbofuran and acephate applied at 1.0 lb. AI per acre were superior to other treatments.

Key Words: West Indian Sugarcane Borer, *Diaprepes abbreviatus*, control, insecticides

INTRODUCTION

The West Indian Sugarcane Root Borer *Diaprepes abbreviatus* L. (Coleoptera: Curculionidae) is an economically important pest in the West Indes. The adults feed on the young foliage of at least 41 plant species (Martorell 1945). The larvae are more destructive than the adults due to their root-feeding habits. Wolcott (1948) reported that they feed on any available live root or tuber; however, the most important hosts are sugarcane and citrus.

This insect was first found in the United States near Apopka, Florida in 1964 (Woodruff 1964). By 1968, approximately 6,500 acres were planted under quarantine by the Florida State Department of Agriculture (Woodruff 1968). Because of the potential spread and economic impact of this insect, containment measures were soon initiated by the Florida State Department of Agriculture in cooperation with the U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine Programs. One important facet of the containment program was the use of foliar sprays to reduce adult populations in commercial citrus groves.

Preliminary tests of foliar sprays on Florida citrus for control of adults were reported by Bullock (1971). Wong *et al.* (1975) tested 21 foliar sprays for residual activity and found that the Sevin-4-Oil formulation of carbaryl (1 oz. AI/tree) gave 100% control for at least 26 days. In a subsequent paper, Wong *et al.* (1975) reported that the addition of a spreader-sticker (Pinolene) to the Sevin 80 WP formulation gave at least 92% control 22 days after treatment.

Carbaryl (either the oil or the 80 WP formulation) was used in the Federal-State containment program from 1969 to 1974 (Gaddis, personal communication). By 1975, program personnel noted that aerial applications

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of the 80 WP formulation (2.0 lbs. AI per acre) failed to give adequate control. Also, mite and aphid buildup in some groves was attributed to the use of carbaryl. Therefore, we initiated a testing program to develop an alternate insecticide for control of adult *D. abbreviatus* on citrus. Reported here are the results of field tests with 13 compounds applied by a jeep-mounted airblast sprayer, and one aerial field trial with five compounds.

METHODS AND MATERIALS

Ground Tests – All tests were conducted in an infested orange grove located near Apopka, Florida, from June 17 to September 20, 1975. Insecticide sprays were applied with a jeep-mounted airblast sprayer (Buffalo Turbine, Model 14, Type GA)[3] calibrated to deliver two gallons of finished spray per acre. Field-collected weevils were held in the laboratory for 24 hours before testing.

Immediately prior to each treatment, five unsexed weevils were confined in each of ten 15.2 x 15.2 cm cylindrical screen cages constructed from 8 x 8 mesh hardware cloth. The cages were then suspended approximately 1.5 meters above the ground on the outer limbs of orange trees (one cage per tree). A 10 cm section of new growth citrus terminal (flush) maintained in an 88 cc plastic dessert cup filled with water was placed in each cage to provide food for the weevils. The cages with the test insects received a direct application of insecticide as the jeep moved parallel to the row of citrus trees (at a distance of 6 meters) with the sprayer in operation. Mortality was assessed at 48 hours after treatment. Most materials were tested at an initial rate of 2.0 lbs. AI per acre. Those giving less than 100% control at this rate were not included in subsequent tests; those materials which did give 100% control in the initial test were retested at lower rates.

Aerial Test – A test to compare the effectiveness of aerial applications of acephate, carbofuran, Carzol, carbaryl 80 WP and ULV malathion was initiated on October 7, 1975. Acephate, carbofuran and Carzol were evaluated in the aerial test because of their prior performance in ground tests. ULV malathion (8 ounces per acre) was tested due to its desirability in terms of relative cost and low mammalian toxicity. Carbaryl 80 WP was included as a standard. Four ounces of Nu-film 17 per acre (spreader-sticker) was included in all treatments except the ULV malathion. Each insecticide treatment was applied to infested citrus groves located near Apopka, Florida, by a spray plane (Cessna® Ag-truck) calibrated to deliver two gallons of finished spray per acre. Each test plot (grove) was five to ten acres in size. Aircraft guidance and swath spacing were provided by Kytoons® tended by ground personnel. Effectiveness of each aerial treatment was assessed by three criteria:

1. *Knock-down* – Knock-down effect of each treatment was determined by randomly placing ten 15.2 cm cylindrical screened cages (each containing 5 field-collected weevils) within each grove immediately prior to treatment. Each cage was suspended about 1.8-2.0 meters above the ground on the outer

[3] Buffalo Turbine Corp., Gowanda, New York.

limb of a citrus tree. Mortality of the caged weevils was assessed at 48 hours after treatment.

2. *Effect on natural infestation* – Pre- and post-treatment infestation counts were taken from 10 trees within each grove with new growth foliage (flush) and weevil feeding signs. Weevil counts were then made by vigorously shaking each tree so that weevils fell onto a 3 x 3 meter drop cloth placed under the tree. This type of count was made 24 hours prior to treatment, one day post treatment, and seven days posttreatment.

3. *Residual effects* – Residual effects of each treatment were bioassayed by caging field-collected weevils in nylon sleeve cages (10 cages/treatment with 5 weevils per cage) on the treated "flush" one day and seven days after treatment. Mortality of caged weevils was assessed after being in contact with the treated foliage for 48 hours.

RESULTS AND DISCUSSION

Ground Tests – Efficacy data for the 13 compounds evaluated in the ground tests are presented in Table 1. Materials and rates which gave 100% mortality included acephate at 2.00, 1.50, 1.00, .50 and .25 lbs. per acre; carbofuran at 2.00, 1.00, .75 and .25 lbs. per acre; Carzol at 2.00, 1.00, .75 and .50 lbs. per acre; Volaton at 2.00 and 1.00 lbs. per acre; and Monitor at 1.00 lbs. per acre. These results indicate that acephate, carbofuran, Carzol, Volatan and Monitor were superior in knock-down and initial kill than the carbaryl standard applied at 2.00 lbs. per acre. Procedures used in this test did not include determination of the residual activity of the various treatments.

Aerial Test – Analysis using three criteria to evaluate the six aerial treatments gave the following results: 1. *Knock-down* – Data on relative knock-down effectiveness of each treatment are shown in Table 2. Acephate applied at 1.0 lb. per acre was the most effective treatment producing 98% mortality of the caged test weevils as compared to 9% for the carbaryl standard 72 hours after treatment.

2. *Effect on natural infestations* – Table 3 presents data on the effects of the various treatments on natural infestations. Carbofuran and acephate were the most effective compounds reducing the pretreatment population by 100% at both one and 7 days after treatment. All treatments, except the untreated control, showed a significant reduction in the posttreatment population as compared to the pretreatment population. However, this reduction may not represent true mortality, but instead may be due to migration of the weevils from the test plots. Insecticidal repellency has been noted in several previous instances. Wolcott (1933) recommended spraying nursery plants with lead or calcium arsenate and stated that the poison does not kill the adults but makes the foliage unpalatable, diverting their attack to other hosts. Lead arsenate was also discussed as a repellent by Fennah (1942). Gaddis (personal communication) noted that Sevin-4-Oil applied to Florida citrus groves dispersed the weevils to adjacent non-citrus hosts. In the present test, ULV malathion and carbaryl appeared to be effective in reducing the natural infestation (Table 3), but were completely ineffective on caged test insects (Tables 2 and

Table 1. – Toxicity of 13 insecticides applied by air-blast sprayer to caged *D. abbreviatus* adults (5 weevils/cage; 10 cages per test series).

Insecticide	Rate/A. (lbs. AI)	Mortality % with No. test series	(48 hrs. posttreatment) Avg. mortality per cage[2]
acephate	2.0	100[2]	5.0 a
acephate	1.5	100[2]	5.0 a
acephate	1.0	100[2]	5.0 a
acephate	0.5	100[2]	5.0 a
acephate	0.25	100[2]	5.0 a
carbofuran	2.0	100[1]	5.0 a
carbofuran	1.0	100[1]	5.0 a
carbofuran	0.75	100[1]	5.0 a
carbofuran	0.25	100[1]	5.0 a
Carzol	2.0	100[1]	5.0 a
Carzol	0.75	100[1]	5.0 a
Monitor	1.0	100[1]	5.0 a
Volaton	2.0	100[1]	5.0 a
Volaton	1.0	100[1]	5.0 a
carbofuran	0.12	99[2]	4.95 a
Carzol	1.0	96[2]	4.8 a b
Carzol	0.5	92.6[3]	4.63 a b
Carzol	0.25	88[1]	4.4 a b c
carbaryl	2.0	88[4]	4.4 a b c
carbofuran	0.06	84[1]	4.2 b c
sumithion	2.0	84[1]	4.2 b c
acephate	0.12	83.4[3]	4.17 b c
trithion	2.0	82[1]	4.1 b c
SD 77250	2.0	76[1]	3.8 c d
acephate	0.06	62[1]	3.1 d
dursban	2.0	62[1]	3.1 d
Imidan	2.0	62[1]	3.1 d
FMC 33297	0.2	62[1]	3.1 d
Systox	1.0	26[1]	1.3 e
Checks[3]	0	Range 2.0-28[11]	Range 0.10- 1.4 e

[1] Data from test series with identical rates were combined. Superscript indicates number of test series/rate. One test series included 10 replicates of 5 weevils/cage.

[2] Numbers followed by similar letters were not significantly different (p=0.05, Duncan's Range Test.

[3] Eleven checks were run, one per test day.

4). Thus, these compounds and possibly other treatments apparently have a repellent effect upon natural populations of this insect.

Table 2. – Knock-down effectiveness of various insecticides aerially applied to caged *D. abbreviatus* adults Apopka, Fl. Oct. 7-9, 1975.

Insecticide	Rate/Acre (AI)	% mortality 48 hrs. after treatment[1]
acephate	1.0 lb.	98 a
acephate	.5 lb	90 a
carbofuran	1.0 lb	82 a
Carzol	1.0 lb.	38 b
ULV malathion	8 oz	24 b c
carbaryl	2.0 lb.	18 c
controls	–	14 c

[1] Numbers followed by similar letters are not significantly different as determined by Duncan's Range Test (p=0.05).

3. *Residual effects* – Carbofuran was the most effective residual treatment, giving 80 and 58% control at one and seven days, respectively, following treatment (Table 4). However, the value of a long residual insecticide is questionable due to the feeding habits of this insect and the growth characteristics of citrus. Feeding is confined almost exclusively to tender young foliage (Wolcott 1936, Woodruff 1968). On citrus the growth rate of this young foliage or "flush" can be so rapid that a 15-30 cm terminal is often

Table 3. – Aerial application of various insecticides for control of natural infestations of adult *D. abbreviatus* on citrus. Apopka, Fl. Oct. 7-9, 1975.

	Rate/Acre (AI)	Date Applied	Pre-treat population[1]	% deviation at indicated days after treatment[2,3]	
				1 day	7 days
carbofuran	1.0 lb.	10/8	14	–100**	–100**
acephate	1.0 lb.	10/9	42	–100**	–100**
acephate	.5 lb.	10/7	23	–47.8NS	–100**
ULV malathion	8 oz.	10/9	15	–93.3**	–53.3NS
carbaryl	2.0 lb.	10/7	49	–69.4**	–87.8**
Carzol	1.0 lb.	10/8	15	–60.00**	– 6.7NS
control	–	10/7	16	– 6.3NS	+18.8**
control	–	10/8	15	+53.3NS	–20.0NScontr
control	–	10/9	15	+13.3NS	0 NS

[1] Based on drop cloth counts on 10 trees in each treatment area.
[2] % deviation = difference between population pre and post-treatment.
[3] Significance determined by paired t-test (10 replicates/treatment). ** = significantly different from pretreat population (p=0.05). NS = Not significantly different; + or – = increase or decrease.

Table 4. – Mortality of caged adult *D. abbreviatus* by residual deposits of various aerially-applied insecticides, Apopka, Fl. Oct. 7-9, 1975.

	Rate/Acre (AI)	Date Treated	% mortality after 48 hrs.[1, 2]	
			1-day residue	7-day residue
carbofuran	1.0 lbs.	10/8	80.0 **	58.0 **
acephate	1.0 lbs.	10/7	50.0 **	26.0 **
acephate	0.5 lbs.	10/7	40.0 **	ND[3]
carbaryl	2.0 lbs.	10/7	32.0 **	26.0 **
Carzol	1.0 lbs.	10/8	14.0NS	ND
ULV malathion	8 oz.	10/9	4.0NS	ND
control	–	10/7	24.0 **	16.0NS
control	–	10/8	6.0NS	ND
control	–	10/9	8.0NS	ND

[1]Test cages set in independent series to determine effects of 1-day residues or 7-day residues.

[2]Significance determined by paired *t*-test (10 reps/treatment): ** = significant mortality due to treatment (p=0.01). NS = mortality due to treatment not significantly different.

[3]ND = effects not determined.

produced within two or three days. Thus, weevils feeding on these new insecticide-free terminals would not come in contact with an insecticide residue deposited two to three days prior to the initiation of the new growth.

ACKNOWLEDGEMENTS

The assistance of T. M. Harris and P. R. Smallwood of USDA, APHIS, PPQ is gratefully acknowledged.

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J. Georgia Entomol. Soc. 11(4), October, 1976, 340-346

A CALIPER FOR MEASURING FIRE ANT MOUND DIMENSIONS

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ABSTRACT

Determination of mound dimension is necessary for biological, chemical control, and ecological studies of *Solenopsis invicta* Buren. A caliper which simultaneously measures the mound diameter and height was developed and its construction and use are reported.

Key Words: Red imported fire ant, *Solenopsis invicta*, ant mounds

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The red imported fire ant, *Solenopsis invicta* Buren, has become one of the most intensely studied ants in North America in recent years (Lofgren *et al.* 1975). Much attention is given to this problem because they construct conspicuous above-ground mounds which when disturbed are vigorously defended by workers. Mound dimensions are important in formulating new chemical control treatments and in biological studies. At the present time, there is no standard method of determining mound dimensions, although many entomologists from Florida to Texas are conducting field research on this ant. I discovered that I was consistently overestimating mound sizes, and therefore developed a tool for fast, accurate measurements.

MATERIALS AND METHODS

The mound-measuring caliper (Fig. 1), consists of two adjustable legs "D" which pivot at point "C". The distance between the lower tips of the two "D" legs is directly read on the scaled slot of arm "B". A scaled sliding vertical bar, "A" (Fig. 2-A), is used to measure the mound height. The inter-