Vol. 72, no. 1

Toxicity and Persistence of Surface Applied and Soil Incorporated Insecticides Against *Diaprepes abbreviatus*[1] Larvae[2]

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ABSTRACT

J. Econ. Entomol. 72: 131–134 (1979)

Laboratory bioassays determined that granular carbofuran, CGA-12223 (*O*-[5-chloro-1-(1-methylethyl)-1*H*-1,2,4-triazol-3-yl]*O*,*O*-diethyl phosphorothioate), Dowco-275 (*O*,*O*-diethyl *O*-(6-fluoro-2-pyridyl) phosphorothioate, and ethoprop applied to the soil surface were efficacious against invasion by *Diaprepes abbreviatus* (L.) neonate larvae one mo posttreatment. Persistence appeared greater in dense soil media. In greenhouse and field tests, larval invasion was prevented by 2 drenches, 12 wk apart, of 0.4 g AI/liter ethoprop. Monthly aldicarb 10G applications did not prevent soil invasion. Aldicarb and ethoprop applications failed to eradicate established larval populations. Additional tests indicated 0.3 g AI/liter drenches of carbofuran or CGA-12223 prevented larval invasion, while concentrations of 1.2 g AI/liter significantly reduced levels of established infestations but were not eradicative. Soil incorporated granular CGA-12223, chlorpyrifos, or ethoprop was ineffective in prevention of larval establishment in soils weathered for 3 mo.

Diaprepes abbreviatus (L.), a sugarcane rootstalk borer weevil, is an important pest of sugarcane, citrus, and ornamentals in the West Indies. In 1964, *D. abbreviatus* was first detected in the United States in central Florida, and by 1977, ca. 4000 ha of citrus as well as several ornamental nurseries in central and south Florida were infested. Adult weevils feed on newly developed foliage whereas the subterranean larvae feed on root tissue and are the primary cause of plant injury and decline. Infestations of ornamental or citrus nurseries result in quarantine restrictions. Previous studies for control of *D. abbreviatus* have included suppression of adults by foliar insecticides (Bullock 1971, Collins et al. 1976, Wong et al. 1975), control of late stage larvae by insecticide dips (O'Neal et al. 1975, Simanton and Bullock 1973), evaluations of ovicidal chemicals (Schroeder et al. 1976, 1977) and laboratory screening of insecticides against neonate larvae (Hamlen and Beavers 1975, Norman et al. 1974). Since neonate larvae drop from oviposition sites within foliage to the soil surface and then migrate into soil, we felt that larvicidal chemicals contained within the upper horizon of the soil present the best method to prevent infestation. Preliminary studies indicated preventative insecticide applications to be promising (Collins et al. 1976, Hamlen and Beavers 1975). Efforts to eradicate late instars from highly organic soils have not been successful, a necessary requirement in order to quarantine this pest (O'Neal et al. 1975). Chlordane is not an effective larvicide, and currently, heptachlor is incorporated into nursery soil media as a preventative to infestation (Collins et al. 1976). Acceptable alternatives to the chlorinated hydrocarbons are needed as these chemicals become limited in usability due to governmental restrictions. Because of the potential economic impact of *D. abbreviatus* on the tropical and subtropical ornamental industry, tests were carried out from 1975–77 in an effort to develop alternative methods to certify nursery stock free of this weevil.

Methods and Materials

D. abbreviatus eggs were obtained from field-collected adults maintained in the laboratory. Newly emerged larvae were transferred to test containers by a 0 camel hair brush.

Laboratory Bioassays 1975

Aldicarb 10G, carbofuran 5G and 10G, chlorpyrifos 10G, CGA-12223 (*O*-[5-chloro-1-(1-methylethyl)-1*H*-1,2,4-triazol-3-yl] *O*,*O*,-diethyl phosphorothioate) 10G, Dowco-275 (*O*,*O*-diethyl *O*-(6-fluoro-2-pyridyl)phosphorothioate) 10G, ethoprop 10G and a ureaform-coated 10G (10G-UF), leptophos 10G, pirimiphos-ethyl 2G, terbufos 15G, and thiofanox 10G were evaluated at 22.4 kg AI/ha as soil surface applications against movement of neonate larvae into soil media. The nursery soil media were: (1) 3 parts Florida peat and 1 part coarse builder's sand (vol/vol) and (2) 2 parts Florida peat, 1 part pine bark, and 1 part cypress shavings (vol/vol/vol). Each soil was amended with 4.1 kg dolomite, 1.8 kg Perk® and 5.9 kg 14-14-14 Osmocote®/m³ and were at a pH of 5.4. Untreated soil was placed 5.1 cm deep in bioassay chambers followed by the uniform distribution of the insecticide over the soil surface and the addition of 10 ml of water. Control chambers contained soil treated with only 10 ml water. Bioassay chambers were similar to those described by Hamlen and Beavers (1975). Twenty neonate larvae (0–24 h old) were placed on the soil surface in each container and incubated under artifical lighting with a 12-h photophase at 25° ± 2°C with 5 replications/treatment. Larvae recovered beneath the bottom of the assay chamber 14 days postinfestation were considered to have survived migration through treated or control soils. Effectiveness of insecticides was evaluated within 18 h following application to the soil. Treated soil also was maintained in a greenhouse and irrigated with 2.0 cm of water/week. Aliquots of leached soil were bioassayed for residual insecticide activity at various posttreatment intervals.

[1] Coleoptera: Curculionidae

[2] Fla. Agric. Exp. Stns. Journal Series No. 1260. Received for publication July 28, 1978. Mention of a trademark name or proprietary product does not constitute a guarantee or warranty by the University of Florida nor the USDA and does not imply its approval to the exclusion of other products that may be suitable. Also, mention of a pesticide does not constitute a recommendation for use by the University of Florida nor the USDA and does not imply registration under FIFRA as amended.

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Greenhouse and Field Tests 1976

Based on the results of previous tests by Hamlen and Beavers (1975) as well as on the availability and usability of insecticides within the ornamental nursery industry, aldicarb 10G and ethoprop 6EC were further evaluated against movement of neonate larvae into nursery soils.

D. abbreviatus-free, ornamental foliage species *Brassaia actinophylla* Endl. (schefflera), *Dracaena fragrans* (L.) Ker-Gawl. 'Massangeana' (corn plant), *Chamaedorea elegans* Mart. (parlor palm), *Ficus benjamina* L. (weeping fig), *Dieffenbachia maculata* (Lodd.) G. Don (dieffenbachia) and *Codiaeum variegatum* (L.) Blume var. *pictum* (Lodd.) Müll. Arg. (croton) were grown in 15 or 20 cm diam containers and maintained on raised greenhouse benches. Woody ornamental species *Viburnum* sp. (viburnum), *Ligustrum lucidum* Ait. (chinese privet), *Rosa* sp., (rose), *Gardenia jasminoides* Ellis, (gardenia), *Podocarpus macrophyllus* (Thunb.) D. Don (Japanese yew), *Pittosporum Tobira* (Thunb.) Ait. (Japanese pittosporum), *Rhododendron* sp. (azalea) and *Citrus* sp. (citrus) were maintained on raised benches outdoors. All plants were allowed to become established for 2 mo. Soil media varied but all were highly organic and were commercial media. Larval populations were initiated (June) in 10 replicated containers, for each of the 14 plant species and the chemical treatments, by infestation with 10 neonate larvae/container/week for 8 or 12 wk, depending on treatment. In assay of preventative ability, 11.2 kg AI/ha aldicarb were applied to the soil surface of containers prior to infestation with 2 additional applications at 4-wk intervals. Following application, 236 ml of water were added to each container. Ethoprop at 0.4 g AI/liter was drenched into containers at 236 and 473 ml/15 and 20 cm container, respectively. Containers were drenched prior to infestation and at 12 wk following continuous, weekly larval infestation. Controls received water drenches. An additional evaluation of ethoprop preventative drenches at 0.4 g AI/liter was completed with 20 replicated, treated and untreated, container-grown *citrus*. All plants were held in a growth room under artificial lighting at ca. 25°C and 60–65% RH. In eradication tests, against larval populations established for 8 wk and at the same concentrations as in the preventative tests, aldicarb was applied at 8 and 10 wk after the initial infestation while a single ethoprop drench was applied at 8 wk postinfestation. Effectiveness of treatments was based on recovery of living larvae from treated and control containers which were broken down 2–4 wk following final chemical applications (Sept.–Oct.). Plants were watered as needed and 14-14-14 Osmocote was applied at 1680 kg N/ha/year. During the study, all plants were sprayed at 3-wk intervals with decachlorobis-2,4-cyclopentadien-1-yl (Pentac® 50WP) at 0.3 g AI/liter, diazinon 4E at 0.6 g AI/liter and 0.2 ml/liter Plyac® (Allied Chemical Co., Atlanta, GA), spreader-sticker, for tetranychid mite and foliar insect control.

Greenhouse and Field Tests 1977

D. abbreviatus-free seedlings of *Ardisia crenata* Sims (coralberry), *Maranta leuconeura* E. Morr. (prayer plant) and *Citrus* sp. were bare-rooted, repotted into 15 cm diam containers with a soil medium of 1 part Florida peat and 1 part mason sand (vol/vol) and maintained on raised greenhouse benches for 4 mo (Apr.–July). These plants were selected because of susceptibility to *D. abbreviatus* larvae (Schroeder et al. 1979). Larval infestation of the 3 plant types was initiated (July) by introducing neonate larvae into container soil for 8–12 wk by methods described for 1976 tests. In evaluation of preventative ability against soil invasion by neonate larvae, 0.3 and 1.2 g AI/liter carbofuran 4F and CGA-12223 4EC were applied as a drench to 20 replicates (236 ml/container) prior to infestation and again 12 wk later. In eradication evaluations against larval populations allowed to become established for 8 wk on each of the 3 plant species, carbofuran 4F and CGA-12223 4EC each at 1.2 g AI/liter were applied as drenches to 10 replicates, 10 wk postinfestation. A series of control plants was drenched with 236 ml water. Again, efficacy was based on recovery of living larvae from treated and control containers (Sept.–Oct.). Cultural and pest management procedures were identical to those of the 1976 tests.

In efforts to evaluate soil incorporated granular insecticides as preventatives to soil invasion by neonate larvae, a soil medium of 1 part Florida peat and 1 part mason sand (vol/vol) was prepared to contain 5.6, 11.2, or 22.4 kg AI/ha each of CGA-12223 10G, chlorpyrifos 15G or ethoprop 10G (Mar.). *Citrus* sp. seedlings were planted in 15 cm diam containers containing each of the chemical treatments. After weathering of planted containers outdoors for 3 mo, 50 neonate larvae were added to each container (May). There were 50 containers/chemical per concentration. Effectiveness was assayed 3 mo postinfestation by examination of seedlings for feeding damage and the presence of larvae.

Results and Discussion

Laboratory Bioassay 1975

Based on low numbers of larvae successfully able to migrate through insecticide treated soils, most chemicals were effective when tested initially (within 18 h postapplication) (Table 1). Chemicals exhibiting most persistence included carbofuran 5 and 10G, CGA-12223 10G, Dowco-275 10G, and ethoprop 10G and 10G-UF. However, no highly residual activity was detected as unacceptable larval invasion began by 4–6 wk posttreatment. No differences were apparent between formulations of ethoprop; however, leached soils treated with carbofuran 5G permitted migration of significantly fewer larvae than the 10G formulation. All tested chemicals were, in general, more effective and persistent in the relatively dense 3:1 soil medium than in the more porous 2:1:1 soil.

Greenhouse and Field Tests 1976

Recovery of larvae from all untreated ornamental plant species was extremely low, i.e., a range of 0–1.5%, compared to 15.6% for untreated *Citrus* sp. This indicated the low host potential of these ornamental species for *D. abbreviatus* larvae (Schroeder et al. 1979) and therefore eradication efficacy was based on only *Citrus* populations. No larvae were recovered from containers that received preventative ethoprop soil drench

Table 1.—Movement of *Diaprepes a* lents of insecticides in laboratory bioas

Chemical	Soil type
Bioassay 1	
Chlorpyrifos 10G	3:1[b]
Chlorpyrifos 10G	2:1:1[c]
Ethoprop 10G	3:1
Ethoprop 10G	2:1:1
Thiofanox 10G	3:1
Thiofanox 10G	2:1:1
Untreated	3:1
Untreated	2:1:1
Bioassay 2	
Aldicarb 10G	3:1
Aldicarb 10G	2:1:1
Carbofuran 10G	3:1
Carbofuran 10G	2:1:1
CGA-12223 10G	3:1
CGA-12223 10G	2:1:1
Dowco-275 10G	3:1
Dowco-275 10G	2:1:1
Leptophos 5G	3:1
Leptophos 5G	2:1:1
Pirimiphos-ethyl 2G	3:1
Pirimophos-ethyl 2G	2:1:1
Terbufos 15G	3:1
Terbufos 15G	2:1:1
Untreated	3:1
Untreated	2:1:1
Bioassay 3	
Carbofuran 5G	3:1
Carbofuran 5G	2:1:1
Carbofuran 10G	3:1
Carbofuran 10G	2:1:1
Ethoprop 10G	3:1
Ethoprop 10G	2:1:1
Ethoprop 10G-UF[d]	3:1
Ethoprop 10G-UF[d]	2:1:1
Untreated	3:1
Untreated	2:1:1

[a] Means in a column within each bioassay no container, 5 replicates/treatment)
[b] Three parts Florida peat and 1 part coarse bu
[c] Two parts Florida peat, 1 part pine bark, an
[d] Ureaform-coated granules

Table 2.—Recovery of *Diaprepes*

Chemical	kg
Aldicarb 10G	
Aldicarb 10G	
Ethoprop 6EC	
Ethoprop 6EC	
Untreated	

[a] Means in a column not followed by the sa
[b] Initial application prior to infestation, 2 ac
[c] Applications at 8 and 10 wk postinitial inf
[d] Initial application prior to infestation and
[e] Application at 8 wk postinitial infestation

Table 1.—Movement of *Diaprepes abbreviatus* neonate larvae through soils surface-treated with 22.4 kg AI/ha equivalents of insecticides in laboratory bioassays—1975.

Chemical	Soil type	$\bar{x}$ no. larvae recovered/container[a] wk posttreatment 0	2	4	6	8	Recovery at 1 month (% untreated)
Bioassay 1							
Chlorpyrifos 10G	3:1[b]	1.2a	1.0a	10.0b			50
Chlorpyrifos 10G	2:1:1[c]	12.0c	10.6c	15.2c			82
Ethoprop 10G	3:1	0a	0a	2.0a			10
Ethoprop 10G	2:1:1	1.4a	6.0b	7.2b			39
Thiofanox 10G	3:1	0a	2.6a	15.8cd			79
Thiofanox 10G	2:1:1	7.0b	11.8cd	19.0de			102
Untreated	3:1	19.8d	10.4c	20.0e			—
Untreated	2:1:1	19.8d	14.6d	18.6dc			—
Bioassay 2							
Aldicarb 10G	3:1	2.6a	9.8d				
Aldicarb 10G	2:1:1	1.4a	15.8e				
Carbofuran 10G	3:1	1.6a	0.6a	0a	1.4a	3.0b	0
Carbofuran 10G	2:1:1	3.8a	5.0bc	5.2de	10.4c		29
CGA-12223 10G	3:1	1.2a	0.2a	0.4ab	1.4a	0.4a	3
CGA-12223 10G	2:1:1	14.8d	7.8cd	6.6e	16.2d		37
Dowco-275 10G	3:1	0.4a	0.6a	0a	2.2a	0.6a	0
Dowco-275 10G	2:1:1	8.6bc	2.8ab	2.2abc	6.0b		12
Leptophos 5G	3:1	17.0d	15.2e				
Leptophos 5G	2:1:1	11.6c	16.4ef				
Pirimiphos-ethyl 2G	3:1	8.0b	1.8a	3.0bcd	2.4a	3.4b	21
Pirimophos-ethyl 2G	2:1:1	9.6bc	17.2ef				
Terbufos 15G	3:1	0.8a	0.2a	0a	4.2ab		0
Terbufos 15G	2:1:1	2.6a	3.2ab	3.2cd	11.2c		18
Untreated	3:1	18.8e	17.0ef	14.4f	15.0d	10.8c	—
Untreated	2:1:1	19.4e	19.0f	17.8g	16.6d		—
Bioassay 3							
Carbofuran 5G	3:1	0a	0.6ab	0a	3.0a	12.2a	0
Carbofuran 5G	2:1:1	0a	0a	0a	0.4a	10.6a	0
Carbofuran 10G	3:1	0a	0a	0a	10.8c		0
Carbofuran 10G	2:1:1	0.2a	0a	0a	6.8b		0
Ethoprop 10G	3:1	0a	1.4abc	0.8ab	11.4c		5
Ethoprop 10G	2:1:1	0a	2.4bc	1.2ab	12.0c		13
Ethoprop 10G-UF[d]	3:1	0a	2.6c	2.4b	12.8c		15
Ethoprop 10G-UF[d]	2:1:1	0a	0.2a	0.2a	9.6bc		2
Untreated	3:1	11.0b	17.2e	16.2d	18.0d	17.4b	—
Untreated	2:1:1	13.6c	15.4d	9.2c	19.4d	16.6b	—

[a] Means in a column within each bioassay not followed by the same letter are significantly different ($P = 0.05$) (Duncan's multiple range test) (20 neonate larvae/container, 5 replicates/treatment)
[b] Three parts Florida peat and 1 part coarse builder's sand (vol/vol)
[c] Two parts Florida peat, 1 part pine bark, and 1 part cypress shavings (vol/vol/vol)
[d] Ureaform-coated granules

Table 2.—Recovery of *Diaprepes abbreviatus* larvae from *Citrus* sp. container grown in insecticide treated soil—1976.

Chemical	Concn kg AI/ha	Concn g AI/liter	Application	$\bar{x}$ no. larvae/container[a] Test 1 10 replicates	Test 2 20 replicates
Aldicarb 10G	11.2	—	preventative, soil surface[b]	18.2b	
Aldicarb 10G	11.2	—	eradicative, soil surface[c]	13.7b	
Ethoprop 6EC	—	0.4	preventative, soil drench[d]	0.0a	0.0a
Ethoprop 6EC	—	0.4	eradicative, soil drench[e]	2.3a	
Untreated	—	—	—	12.5b	16.2b

[a] Means in a column not followed by the same letter are significantly different ($P = 0.05$) (Duncan's multiple range test).
[b] Initial application prior to infestation, 2 additional applications at 4-wk intervals
[c] Applications at 8 and 10 wk postinitial infestation.
[d] Initial application prior to infestation and 12 wk later.
[e] Application at 8 wk postinitial infestation.

applications while a mean of 2.3 larvae/container was recovered with ethoprop applications to established populations (Table 2). Aldicarb preventative and eradication treatments were ineffective and yielded a mean of 18.2 and 13.7 larvae/container, respectively. The mean number of larvae recovered per untreated container was 12.5. In the 2nd evaluation, preventative ethoprop applications totally prevented larval development in treated soil while 16.2 larvae/container were recovered from untreated *Citrus* (Table 2).

Greenhouse and Field Tests 1977

A. crenata and *M. leuconeura* were utilized along with a *Citrus* sp. in this test as these ornamental species had been identified as hosts to *D. abbreviatus* larvae by Schroeder et al. (1978). Living larvae were not recovered from containers drenched with either 0.3 or 1.2 g AI/liter concn of carbofuran 4F or CGA-12223 4EC prior to infestation and again 12 wk later (Table 3). Feeding injury was observed and dead larvae were recovered from one container treated with 1.2 g AI/liter CGA-12223 indicating the low persistence of this chemical and the need for repeated applications. As in 1976 testing, eradicative drench procedures significantly reduced established larval populations in treated soil. However, drench concentrations of carbofuran or CGA-12223, 4 times that required to prevent larval infestation, did not eradicate established populations (Table 3).

When *Citrus* seedlings, grown in granular CGA-12223, chlorpyrifos or ethoprop incorporated soil media, were examined for damage, feeding was evident on the roots, and living larvae were found in all treatments (Table 4). The soil insecticides tested were not effective in preventing *D. abbreviatus* from becoming established on container grown *Citrus* when added to soil as a granular formulation then weathered for 3 mo.

Bioassay procedures were a rapid method of screening numerous chemicals and the reliability of this procedure is indicated in comparison of the relative activity of aldicarb and ethoprop in bioassay testing (Table 1) and the 1976 greenhouse and field studies (Table 2). Carbofuran, CGA-12223 and ethoprop appeared highly toxic to neonate as well as to cal. 8- to 10-wk-old larvae. Bioassay results indicated the short soil residual activity of these chemicals; however, repeated drenches at 3-mo intervals appeared promising as infestation preventative treatments. Eradication of established populations was not successful.

Table 3.—Recovery of *Diaprepes abbreviatus* larvae from ornamental plants and *Citrus* sp. container grown in insecticide treated soil—1977.

Chemical	g AI/liter	x̄ no. larvae/container[a]		
		Ardisia	*Maranta*	*Citrus*
Preventative drenches[b]				
Carbofuran 4F	0.3	0a	0a	0a
	1.2	0a	0a	0a
CGA-12223 4EC	0.3	0a	0a	0a
	1.2	0a	0a	0a
Untreated	—	9.2b	1.0b	7.6b
Eradicative drenches[c]				
Carbofuran 4F	1.2	0.1a	0a	0.6a
CGA-12223 4EC	1.2	0.1a	0.2a	0.5a
Untreated	—	10.0b	1.1b	9.6b

[a] Means in a column within each test not followed by the same letter are significantly different ($P = 0.05$) (Duncan's multiple range test)
[b] Initial application prior to infestation and 12 weeks later (20 replicates).
[c] Application 10 weeks postinitial infestation (10 replicates)

Table 4.—Recovery of *Diaprepes abbreviatus* larvae from *Citrus* sp. container grown in insecticide incorporated soil weathered for 3 months—1977.

Chemical		kg AI/ha[a]	No. containers with larvae[b]
CGA-12223	10G	5.6	2
CGA-12223	10G	11.2	17
CGA-12223	10G	22.4	22
Chlorpyrifos	15G	5.6	50
Chlorpyrifos	15G	11.2	50
Chlorpyrifos	15G	22.4	15
Ethoprop	10G	5.6	50
Ethoprop	10G	11.2	50
Ethoprop	10G	22.4	50

[a] Computed on incorporation to a 15-cm depth.
[b] 50 replicates

REFERENCES CITED

Bullock, R. C. 1971. Effectiveness of foliar sprays for control of *Diaprepes abbreviatus* L. on Florida citrus. Trop. Agric. 48: 127–31.

Collins, H. L., C. L. Mangum, and D. E. Hendricks. 1976. Evaluation of foliar sprays for control of adult *Diaprepes abbreviatus* L. on Florida citrus. J. Ga. Entomol. Soc. 11: 340–6.

Collins, H. W., Jr., W. J. Schroeder, R. A. Sutton, and A. Donnan, Jr. 1976. Control of neonate larvae of *Diaprepes abbreviatus* (L.) in potting soil. Proc. Fla. State Hortic. Soc. 89: 335–6.

Hamlen, R. A., and J. B. Beavers. 1975. Evaluation of soil fumigants and soil insecticides to control *Diaprepes abbreviatus* in muck and potting soils. Ibid. 88: 518–22.

Norman, P. A., R. A. Sutton, and A. G. Selhime. 1974. Laboratory evaluations of insecticides against larvae of *Diaprepes abbreviatus*. J. Econ. Entomol. 67: 694–5.

O'Neal, J., C. L. Mangum, and T. M. Harris. 1975. Evaluation of insecticidal dips for effectiveness against *Diaprepes abbreviatus* larvae infesting nursery stock. Ibid. 68: 650–2.

Schroeder, W. J., R. A. Hamlen, and J. B. Beavers. 1979. Influence of host plants on the development of *Diaprepes abbreviatus* larvae. Ann. Entomol. Soc. Am. (In press).

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

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.

Simanton, W. A., and R. C. Bullock. 1973. Evaluation of dip treatments to destroy *Diaprepes abbreviatus* on citrus nursery trees. Fla. Entomol. 56: 305–10.

Wong, T. T. Y., R. A. Sutton, J. B. Beavers, and P. A. Norman. 1975. Field tests of insecticides for control of adult *Diaprepes abbreviatus* on citrus. J. Econ. Entomol. 68: 119–21.

Sustained-release Far

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When cattle were infuse
1-host ticks, 3 mg famphu
(Say), *B. microplus* (Cane
highly effective against th
Administration of famphur
philus when the insecticide
famphur/kg animal body w

Since 1943, the quarantine and treat
the buffer zone in south Texas have be
spread of fever ticks (*Boophilus* spp.)
the United States from Mexico. These
rimental in 1906 that they caused dire
nomic losses of $130 million to south
ducers (Graham and Hourrigan 197
Hourrigan (1977) noted that for a 20-
1968 *Boophilus* spp. were not found i
the established buffer zone but that s
rate outbreaks have occurred north of
less than a decade. Although the thre
the southern cattle industry is difficu
fever (bovine babesiosis) and the po
anaplasmosis that may be associated
tate that surveillance, quarantine,
maintained at a cost of millions of d

Currently, outbreaks of *Boophilus*
either by the systematic dipping of c
ca. 6–9 mo or by pasture spelling.
requires enormous outlays in manp
that cattle are dipped every 14 days
may result in inefficient land usag
development of a long-term sustaine
taining a systemic insecticide that
Boophilus might result in the eve
present control practices to a mo
treatment which could eliminate
costs of animal handling. Our event
a bolus that would provide treatm
such a treatment might further se
pests including the horn fly, *Haem*
and the common cattle grub, *Hypo*
ers).

Two components of a bolus are
achieve our stated goal. First, the
effective systemic insecticide tha
from the rumen and which does n
lems at the time of animal slaug
pesticide must be relatively nonto

[1] Acari: Ixodidae.
[2] This study was made possible through a sab
Oklahoma State University and collaboratorship
paper reflects the results of research only. Ment
pesticide does not constitute a recommendation
imply registration under FIFRA as amended. R
1978. Paper No. 3543 of the Oklahoma Agricult
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