EFFICACY OF A COCKROACH CONTROL BAIT EXPOSED TO INSECTICIDES

WILLIAM H ROBINSON AND ROBERT A. BARLOW
Urban Pest Control Research Center, 610 North Main Street, # 176, Blacksburg, Virginia 24060-3349 USA

Abstract - Combining methods for cockroach control is often prevented by the perception that gel baits are easily contaminated by other insecticides. The objectives were to determine the ability of liquid and dust insecticides to contaminate a cockroach control bait. A gel bait (Maxforce, 2.15% hydramethylnon) was used in all the tests; beads of gel were treated with the liquid chlorpyrifos, cypermethrin, cyfluthrin, deltamethrin, and pyrethrins; and with dust cyfluthrin, and deltamethrin. German cockroaches used were from a field strain (RHA) and a susceptible laboratory strain. Treated baits and alternative food and water were placed in jars containing 10-15 male cockroaches. Treatments were replicated three times, and cockroach mortality recorded daily. Insecticides were applied to the surface of the gel at the rate of 1 and 5 microliters. Dusts were applied at the label recommended rates for cyfluthrin and deltamethrin. The results indicate that the application of chlorpyrifos, cypermethrin, and deltamethrin did not deter the cockroaches from eating the bait. The presence of low concentrations of pyrethrins was not repellent and did not deter the cockroaches from the bait. The application of dust formulations of insecticides had a limited effect on cockroach feeding.
Key words - Gel bait, German cockroach, control, hydramethylnon

INTRODUCTION

The use of toxic baits for cockroaches has significantly changed the way these pests are controlled. Traditionally, cockroach control was based on the application of liquid or dust formulations of insecticides in or near infested harborages. Mortality occurred when adults and nymphs walked across the residue on treated surfaces and a lethal amount of insecticide was transferred to the tarsal pad (Zhai and Robinson 1994). Mortality from baits occurs after individuals ingest a lethal quantity of the insecticide incorporated into a palatable matrix. Baits have become an effective alternative to surface treatments in control programs around the world (MacDonald *et al.*, 1987; Koehler and Patterson, 1991; Appel, 1990, Short *et al.*, 1993).

Palatability and attractiveness of the bait matrix to cockroaches are key factors in the efficacy of gel baits (Barlow, 1996). They are generally exposed to the environment and subject to water loss and contamination from other insecticides or household materials (Ajjan *et al.*, 1997). It is generally thought that if baits are used along with other insecticides in a control program they will become contaminated, and the presence of another insecticide will reduce palatability or act as a repellent. Consequently, baits are usually recommended for use alone and not combined with other chemical strategies in a professional pest control program (NPCA, 1997).

The availability of liquid and dust formulations for cockroach control, and the utility of containerized (plastic stations) and exposed (gel formulation) baits, provides the opportunity for integrated control programs for cockroaches. These programs are often limited by the perception that containerized or exposed bait may be contaminated by other insecticides and household cleaning materials. However, there is little or no evidence confirming insecticide contamination, or documenting the loss of efficacy of bait formulations exposed to other active ingredients. The objective of the research presented here was to evaluate the effect of exposure to liquid and dust formulations of organophosphate, pyrethroid, and pyrethrin insecticides on the efficacy of a gel bait against the German cockroach, *Blattella germanica* (L.).

MATERIALS AND METHODS

Cockroaches

The adult, male German cockroaches used in all evaluations were taken from laboratory colonies maintained on rat chow and water, and reared at 27 +2 ºC, 60±10% RH, with a photoperiod of 12:12. The

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RHA strain was established from adults and nymphs collected in urban apartments in Roanoke, Va. This strain has moderate level resistance to hydramethylnon (Ajjan and Robinson, 1996), organophosphate, and pyrethroid insecticides (Zhai and Robinson, 1996). The VPI is a susceptible strain that has been in colony for about 200 generations.

Test arena

Glass jars (16.5 cm dia, 20 cm high) were provided with a water source and a pellet of rat chow; petroleum jelly was applied to the inside of the jar, 5 cm from the top, to keep the cockroaches inside. Cockroaches were permitted to acclimate to the jar for about 24 h before the insecticide-treated baits were introduced. Treated baits on plastic trays (4.5 cm dia.) were positioned equidistant from the rat chow and water source. Cockroaches were observed daily and mortality was recorded; dead cockroaches were removed from the jars during the test.

Treated baits

A gel bait (Maxforce, The Clorox Co., Pleasanton, CA), containing 2.15% (AI) hydramethylnon, was used in the evaluations. A bead (62 mg) of bait, approximately 0.7 cm in diameter was placed in the plastic tray using a syringe. Within 1 h the baits were treated with the candidate insecticide. Baits were treated individually with a 1 µl droplet or five, 1 µl droplets of a water dilution of the candidate insecticide. Application was done with a calibrated microapplicator (Burkard Manufacturing Co., Herts, UK). The one droplet was placed nearly at the center of the bait, and the five droplets were placed so as to nearly cover the entire surface of the bait bead, but without contacting the plastic tray.

Insecticide dusts were applied to the surface of the bait with the aid of a small brush. For the application of 0.2 mg, the dust covered approximately one-fifth of the bait surface; for the application of 1.0 mg, the dust covered the entire surface of the bait surface.

Evaluations were also conducted with a nontoxic formulation of the gel bait (The Clorox Co., Pleasanton, CA). The amount of bait used and the method used to treat with a 0.06% (AI) dilution of deltamethrin insecticide was the same as for the toxic formulations.

Insecticides

The insecticides and concentrations (percentage AI, formulation) used in the evaluations were: chlorpyrifos (0.5% emulsifiable concentrate), cypermethrin (0.2% emulsifiable concentrate), deltamethrin (0.06% suspension concentrate; 0.05% dust), cyfluthrin (0.1% emulsifiable concentrate; 0.1% dust), silicon dioxide (83.6% dust), pyrethrins (3% oil-based concentrate, plus 6% piperonyl butoxide, and 10% MGK-264), pyrethrins (3% water-based concentrate, plus 15% piperonyl butoxide).

RESULTS AND DISCUSSION

These evaluations were designed to detect whether small (1 ml) or large (5 ml) amounts of liquid or dust insecticide on the surface of gel bait would contaminate the material to the point of reducing acceptance by German cockroaches. Contamination is indicated by reduced feeding and decreased bait efficacy. The results indicate that, except for pyrethrins, the liquid insecticides applied at the 1 ml or the 5 ml rate did not act to reduce feeding. The mortality data indicate that cockroaches were apparently not deterred from feeding on the treated baits. The mortality of RHA cockroaches exposed to the treated baits is consistent with the LT_{90} (days) value of 3.35 (CI 2.51- 4.68) reported by Ajjan and Robinson (1996).

Liquid formulations

The application of 1 µl or 5 µl of chlorpyrifos, cypermethrin, or deltamethrin to the baits had no apparent repellent effect on the feeding of RHA cockroaches. The 93-100% mortality recorded within 4 days of exposure to the treated baits is consistent with the expected LT_{90} values for hydramethylnon.

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(Table 1). The application of cyfluthrin to the baits may have resulted in limited repellency. For baits with 1 ml cyfluthrin there was 80% mortality at 4 and 5 days; for baits treated with 5 µl there was only 27% mortality at 4 days and 33% at 5 days (Table 2). These low mortality rates indicate that the cockroaches did not eat the treated bait and may have been repelled by the presence of this insecticide.

Table 1. Mortality of male German cockroaches exposed to gel bait with the surface treated with 1 µl or 5 µl of liquid insecticide.

Insecticide/Strain	Application (no. µl)	Percentage mortality		
		3 days	4 days	5 days
0.5% chlorpyrifos				
VPI	1	60	100	
VPI	5	83	100	
RHA	1	—	100	
RHA	5	67	100	
0.2% cypermethrin				
VPI	1	—	63	93
VPI	5	—	67	97
RHA	1	87	100	
RHA	5	87	100	
0.06% deltamethrin				
VPI	1	53	80	87
VPI	5	27	60	80
RHA	1	87	100	
RHA	5	93	93	100
0.1% cyfluthrin				
VPI	1	87	73	100
VPI	5	67	73	100
RHA	1	73	80	80
RHA	5	7	27	33

Table 2. Mortality of male German cockroaches exposed to gel bait treated with the surface treated 1 µl or 5 µl of liquid insecticide.

Insecticide/Strain	Application (no. µl)	Percentage mortality		
		6 days	7 days	14 days
3% pyrethrins, 6% PB				
VPI	1	13	53	100
VPI	5	0	7	80
RHA	1	7	7	27
RHA	5	0	0	13
3% pyrethrins, 15% PB				
VPI	1	100		
VPI	5	60	73	79
RHA	1	27	27	60

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The presence of pyrethrins on the surface of the baits appeared to significantly deter feeding by RHA and VPI cockroaches. At 7 days after treatment the range of mortality was 0 - 27%, and at 14 days the mortality ranged from 13 to 60% (Table 3).

Table 3. Mortality of male German cockroaches exposed to gel bait with the surface treated with 0.2 mg or 1.0 mg of dust insecticide.

Insecticide/Strain	Application (mg of dust)	Percentage mortality		
		3 days	4 days	5 days
83.6% silicon dioxide dust				
VPI	0.2	73	100	
VPI	1.0	100		
RHA	0.2	47	56	67
RHA	1.0	33	40	53
0.1% chfluthrin dust				
VPI	0.2	73	87	100
VPI	1.0	80	100	
RHA	0.2	67	73	80
RHA	1.0	53	80	87
0.05% deltamethrin dust				
VPI	0.2	87	100	
VPI	1.0	67	73	100
RHA	0.2	64	79	93
RHA	1.0	50	64	64

Dust formulations

The presence of dusts on the surface of the bait appeared to limit the feeding by RHA cockroaches (Table 3). The presence of silicon dioxide resulted in a mean mortality of <50% for RHA at 4 days for both the 1 and the 5 application; there was 100% mortality of the VPI cockroaches at 4 days after treatment. Less feeding avoidance resulted form the presence of the pyrethroid dusts on the baits. By 4 days the mean RHA mortality was 70%.

Blank bait

There was no mortality after 5 days of RHA and VPI cockroaches feeding on nontoxic (blank) bait with 1 ml of deltamethrin (0.06%). Apparently this small amount of insecticide was not sufficient to kill. Feeding on the blank bait with 5 ml of insecticide resulted in 73% mortality of VPI and no mortality of RHA cockroaches. The level of pyrethroid resistance in the RHA cockroaches (Zhai and Robinson, 1996) may have influenced the mortality due to deltamethrin. The results of the evaluation with the blank bait confirms that cockroach mortality in the other tests is primarily due to the bait toxicant, hydramethylnon.

The data on the liquid formulations has direct relevance to the use of baits and insecticide sprays in cockroach control programs. Typically, liquid insecticides are applied with a compressed-air sprayer using a fan orifice, such as the 800067 fine fan (B&G Equipment Co.). The volume median diameter (VMD) droplet for this orifice is 130 µm (Zhai and Robinson 1994), and the amount of liquid in each 130 mm droplet is 1 nl. In the research presented here, the 1 µl and 5 µl application on the bait simulated the dose delivered by contact with 1000 and 5000 of the 130 µm drops from the 800067 orifice, respectfully.

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For years numerous trade publications have contributed to the idea that cockroach control baits would become contaminated if exposed to insecticides and household cleaning products, that mere storage with insecticides or simply handling baits after applying liquids or dusts would lead to contamination, and that baits could not be reasonably combined with other cockroach control strategies. These ideas fit so well with the perceptions that insecticides are naturally repellent to insects, and baits are a fragile piece of technology that they have become accepted fact. The persistence of the bait-contamination theory is unfortunate, and the intuitive bases for it may be difficult to correct.

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