Are Dusts the Bed Bug Bullet?

By Alvaro Romero, Michael F. Potter and Kenneth F. Haynes • Contributors

Dusts have been used for pest management since the beginnings of recorded time. Primitive tribes (as well as birds and other animals) instinctively took "dust baths" to fend off lice, mites and other parasites residing in their hair, fur or feathers. Early civilizations also used clay and other dusty materials to protect grains and nuts from insect attacks during storage.

Dusts likewise have a long history of being used to manage bed bugs. Diatomaceous earth was used to kill bed bugs and other vermin for thousands of years. Pyrethrum powder also was used long ago, and travelers often carried it with them to dust between the sheets in hotel rooms. Even DDT was formulated as a dust for bed-bug control, although sprays generally were more popular.

Today's lack of reliable bed bug products requires that we consider all options for elimination. While much has been said about sprays, little has been reported on the efficacy of dust formulations. This article presents some of our initial findings and discusses the increasingly important role dusts might play in bed-bug management programs.

Study Methods

Four different bed bug populations were exposed to insecticide dusts in the laboratory. Two of the populations (CIN–1 originating from Cincinnati, and NY-1 from New York) were previously determined to be highly resistant to pyrethroids. We evaluated a third field population from Los Angeles (LA-1) deemed moderately pyrethroid susceptible. For comparison, we also tested the susceptibility of a fourth population originating from Ft. Dix, N.J., that had been maintained by Dr. Harold Harlan for more than 30 years without exposure to insecticides.

We tested five different dusts representing two insecticide categories: two pyrethroid-based dusts, DeltaDust (deltamethrin 0.05 percent) and Tempo 1% Dust (cyfluthrin 1 percent); and three desiccant dusts, Drione (pyrethrins 1 percent, piperonyl butoxide 10 percent, amorphous silica gel 40 percent), MotherEarth D (diatomaceous earth 100 percent), and NIC 325 (limestone 99.5 percent). The efficacy of each product was evaluated by confining adult bed bugs (three replicates of 20 insects) from the respective populations on black filter paper circles treated at label rates, (or about 200 mg of dust per cm^2). Exposure of bed bugs to the dusts was continuous, and mortality was recorded daily.

Results

Cumulative mortality of each bed bug population from continuous exposure to the dusts is shown in Figures 1 and 2. Tempo Dust killed 100 percent of the bugs from all four populations within 24 hours of exposure — a surprising outcome considering that two of the strains (NY-1 and CIN-1) were highly resistant to pyrethroids formerly administered as liquids. Drione, which includes silica gel, pyrethrins and piperonyl butoxide also produced 100 percent mortality of all populations, although 72 hours were needed to kill all bugs in the two resistant strains from New York and Cincinnati. Variable results occurred with DeltaDust depending on the resistance level of the population. While most bed bugs in the pyrethroid susceptible LA-1 and Fort Dix strains died within 24 hours, more than a week was needed to kill 100 percent of the bugs from the resistant New York strain and two weeks to kill 93 percent from the resistant Cincinnati strain. MotherEarth D (diatomaceous earth) was slower acting than Tempo or Drione, but caused substantial (>90 percent) mortality of susceptible and resistant bed bugs within four days and all bed bugs were dead after 10 days. Mortality was notably lower with limestone-based NIC 325 on all populations tested and did not exceed 50 percent even after 13 days of continuous exposure.

Implications

It was encouraging to see the high levels of mortality achieved with some dusts on the market, especially against bed bug strains that are highly resistant to pyrethroid sprays. The results were perhaps less surprising with Drione and MotherEarth, which cause desiccation and death by removing the ultra-thin, protective layer of wax from the outside of an insect. Recent studies have shown that bed bugs are adept at conserving moisture, which is the main reason they can survive so long (a year or longer depending on conditions) without a blood meal. Our findings suggest this survival tactic can be overcome by exposure to dust desiccants, a vulnerability that may be worth

From the May 2009 issue of **PMP** Magazine

exploiting to a greater extent in bed bug management.

There are two main mechanisms by which dusts can desiccate insects. Like superfine sandpaper, certain dusts, including diatomaceous earth, kill principally by abrading the protective outer layer of wax as the insect crawls over or through the abrasive particles[1]. Silica gels contained in Drione and Tri-Die function more like a sponge, absorbing the ultra thin lipid layer onto the particle matrix. In the 1960s, *PMP* Hall of Famer Dr. Walter Ebeling and other researchers found that sorptive dusts[1] (the most effective tested being silica aerogels[2]) were lethal to cockroaches, drywood termites and other household insects. While abrasive dusts such as diatomaceous earth also were effective, highly absorptive dusts (e.g., silica aerogels) generally were the most potent under practical pest control conditions. It should be noted that boric acid is not considered a desiccant and presumably has little effect on bed bugs since it must be ingested. None of the aforementioned dusts kill insects by clogging the breathing pores (spiracles) as is sometimes erroneously believed. Drione and Tri-Die formulated as bulk dusts also contain pyrethrins, piperonyl butoxide and petroleum distillate, which may further contribute to the effectiveness of these products against bed bugs.

Unexpected in our study was the outcome with pyrethroid dusts — especially Tempo, which killed all bed bugs from both non-resistant and resistant populations within 24 hours. DeltaDust had a similar rapid effect against pyrethroid susceptible populations (Ft. Dix and LA-1), but took longer to kill resistant strains (CIN-1 and NY-1). How these products managed to kill pyrethroid resistant bed bugs is still under investigation. Possibilities include enhanced uptake of pyrethroid active ingredients or mortality resulting from other 'inert' components of the formulation. Dust formulations often contain additives (diluents) which serve as carriers, fillers, extenders or dispersants. Some of these presumed inert ingredients may also have insecticidal action against bed bugs and could warrant further evaluation by manufacturers.

Rethinking the Role of Dusts

Many companies currently use dusts when treating for bed bugs (*PMP*, January 2008, pg. 24). Treatment typically is to such areas as behind outlets and switch plates, beneath baseboards and carpet edges, and to the inner framework of couches and box springs. Pressurized dusts (e.g., Tri-Die) also are injected into cracks and crevices. Firms often are hesitant to apply dusts more extensively for bed bugs because they can be messy when used liberally, especially in living areas.

Nonetheless, dusts have important characteristics that help in managing bed bugs. Perhaps foremost, they appear to be one of the few insecticide options available today that retain their effectiveness as a residual deposit. Most liquids we've tested against field populations kill mainly upon contact, i.e., for maximum effectiveness the bugs must be sprayed directly. In commercial practice, this is often hard to do because some bed bugs remain hidden. Moreover, few products destroy the eggs. Consequently, treatments lacking residual action must be reapplied to control both bugs that were missed and any newly emerging nymphs. Dust formulations such as those containing silica gel or diatomaceous earth retain their potency for many months or years when applied into wall and cabinet voids — and presumably would do the same under baseboard and carpet edges, the inner framework of box springs and sofas, and in other "buggy" locations. The physical properties of dust particles enable them to be picked up readily by crawling insects. In our lab studies, we have noticed that barely visible deposits still result in an accumulation of dust on the underside of a bed bug, especially toward the rear of the abdomen.

Unlike some sprays, dusts tend to have rather permissive labels for treatment of bed bugs. Drione and Tri-Die can be applied directly to beds including the tufts, folds and edges of the mattress. Tempo Dust and DeltaDust have similar label provisions, although the powder must be vacuumed up after four to six hours from mattresses, upholstered furniture and other human contact surfaces. Diatomaceous earth (e.g., MotherEarth D) currently does not include treatment guidelines for bed bugs, although future labeling also may be permissive.

Desiccant dusts such as silica gel and diatomaceous earth have notably low toxicity to humans. Nonetheless, any dust insecticide should be applied with care, especially within living areas. Just as odor can trigger concern following spray applications, the presence of white powder can be perceived as dangerous whether it is or not. Companies deploying dusts should try not to leave visible traces on floors or other surfaces. They also would be wise to carry a vacuum and promptly remove any visible deposits. Battery-powered or electric dusters such as the Exacticide or

Techniduster (Technicide in San Clemente, Calif.) or PowerPuff (Gremar in Des Moines, Iowa) efficiently deliver fine dust deposits that are often harder to achieve consistently with a hand duster.

Final Thoughts

History provides important lessons on the most effective methods to eradicate bed bugs. While many of the same non-chemical approaches (vigilance, laundering, heat, cold, bug-proofing, community education) were employed then as they are now, it was residually potent insecticides — initially DDT, followed by malathion, diazinon, etc. — that caused this detested household pest to all but disappear for the first time in centuries. One thorough application of these older insecticides usually did the job since bugs residing in hidden locations and nymphs hatching from eggs succumbed after resting or crawling on previously treated surfaces. Lacking similar residual potency with most of today's sprays, dust formulations could play an increasing role remedially and for prevention in selected places where bed bugs initially tend to seek harborages.

As we await the next bed bug "silver bullet," dusts may buy us some time. It would be fitting indeed if such ancient tools helped defeat such an ancient pest. **PMP**

Alvaro Romero is a Ph.D. student at the University of Kentucky.
Michael F. Potter and Kenneth F. Haynes are entomology professors at the same institution. To reach Potter, e-mail mpotter@email.uky.edu.

[1] Ebeling, W. 1971. "Sorptive dusts for pest control." Ann. Rev. Entomol. 16:123-158.

[2] The terms silica gel and silica aerogel are often used interchangeably in the pest management literature. Silica gels consisting of extremely small, lightweight and porous particles are called 'aerogels,' which tend to be most efficacious as insect desiccants. Formulation often gives the tiny silica particles an electrostatic charge that further helps them adhere both to application surfaces and insects.

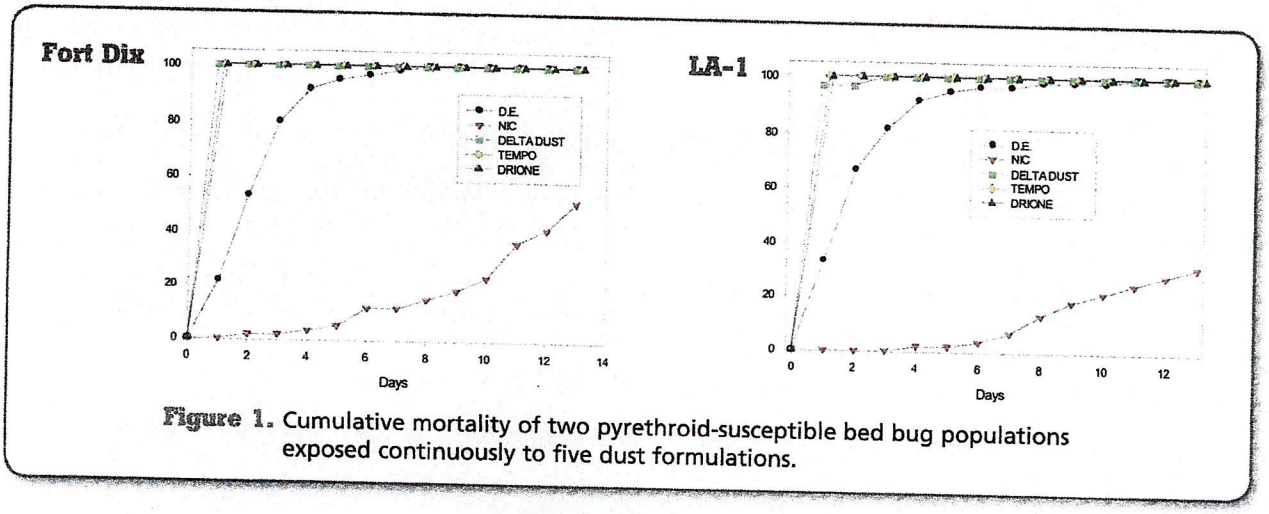

Figure 1. Cumulative mortality of two pyrethroid-susceptible bed bug populations exposed continuously to five dust formulations.

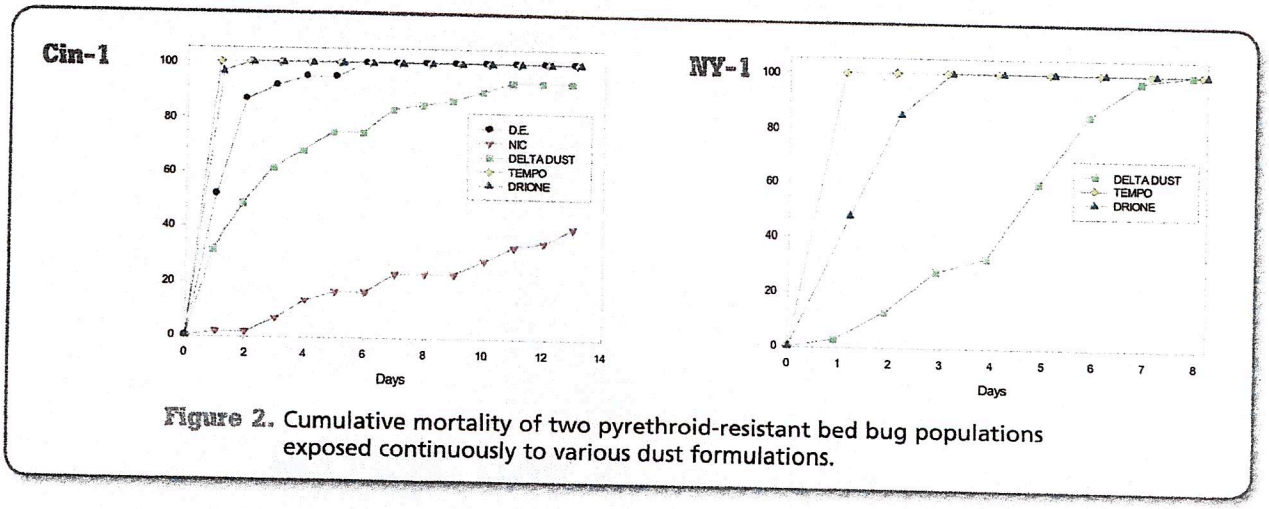

Figure 2. Cumulative mortality of two pyrethroid-resistant bed bug populations exposed continuously to various dust formulations.