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One-Two Punch

Bed Bug Supplement - Bed Bug Supplement

Research out of New Mexico State University discusses control of pyrethroid-resistant bed bug strains with a combination of ß-cyfluthrin and imidacloprid, and how surface materials greatly affect residuality and toxic activity of insecticides.

June 14, 2017

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By Alvaro Romero and Brittny N. Blakely

Difficulty eliminating some bed bug populations in recent years has prompted the use of multiple pest control tactics, including the use of insecticide formulations with distinct active ingredients. Products containing neonicotinoid and pyrethroid insecticides are today's mainstay products for bed bug control. Here, New Mexico

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State University researchers show evidence that these mixtures can be very effective against bed bug populations with different degrees of pyrethroid resistance; however, efficacy of these insecticides may vary, depending on the substrates used.

Bed bugs continue to be a challenging pest to control because of their cryptic nature – they can hide almost anywhere, making detection difficult – and their ability to develop resistance to insecticides. Difficulties in controlling bed bug populations have prompted continued development and implementation of more effective tools for detecting infestations, especially at early stages, as well as the incorporation of nonchemical methods in bed bug management programs.

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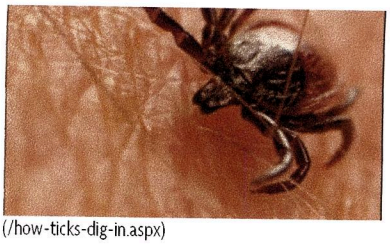
Figure 1. Bed bugs resting on porous materials

Nevertheless, surveys confirm that most pest management professionals rely on insecticides as part of their bed bug control program (Sutherland et al. 2015). Given widespread prevalence of pyrethroid resistance among bed bug populations in the United States, a number of insecticide formulations, such as those containing neonicotinoids (Alpine, BASF) or those containing pyrethroids and neonicotinoids (Temprid SC, Bayer Environmental Science; Tandem, Syngenta Crop Protection; Transport Mikron and Transport GHP, FMC Professional Solutions), have been introduced to the market. It is expected that the combination of active ingredients produces better results against pyrethroid-resistant populations.

A number of field and lab evaluations have been conducted to determine the efficacy of these insecticide combinations (Potter et al. 2012, Wang et al. 2015, Wang et al. 2016). Although field studies show that application of these mixtures reduce the



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number of bed bugs in infested places, laboratory information about the efficacy of dry residues in common substrates — where bed bugs aggregate under these insecticide combinations — is just beginning to be generated.

This study presents information about the efficacy of Temprid, one of the most commonly used products for bed bug control. This information will expand our knowledge about the impact of these combinations against bed bug populations with different levels of pyrethroid resistance.

THE STUDY. A series of experiments to evaluate the efficacy of Temprid were conducted on two moderately pyrethroid-resistant field populations (KRU and Washington, collected at different sites in Washington, D.C.). KRU and Washington had 50% and 70% mortality, respectively, when exposed to 0.06% deltamethrin in filter paper. A fifth field population (Jersey City), highly resistant to pyrethroids (20% mortality) was included in the study. Three susceptible populations, South Carolina, Indianapolis and Harlan, were used as reference populations.

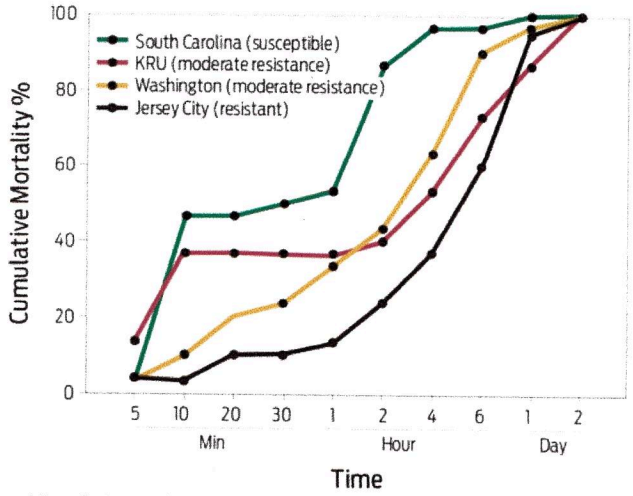


Figure 2. Cumulative effect among bed bugs exposed to Temprid through direct sprays.

In one trial, adult bed bugs (three replicates of 10 insects) from the susceptible South Carolina population and the moderately resistant KRU and Washington populations were placed in petri dishes that were fitted with filter paper and were sprayed directly with a combination product (Temprid SC, 0.075 percent A.I.) or with water alone.

The sprayed bed bugs remained in the arena for 1 hour and then transferred to a clean area where mortality was monitored for 24 hours.

A second trial evaluated the effectiveness of fresh dry residues of Temprid against the same moderately resistant KRU and Washington populations used in the first trial and another susceptible reference population (Indianapolis). Adult bed bugs (three replicates of 10 insects) were confined to pieces of fabric (65 percent polyester and 35 percent cotton) or pieces of plywood treated the day before the trial with the combination formulation. Bed bugs remained in the treated substrates for 4 hours and were then moved to clean areas to be observed. Other groups of the same bed bug populations were exposed to Temprid deposits aged under laboratory conditions for one, two and three months.

In the last trial, adult bed bugs (three replicates of 20 insects) of the highly pyrethroid-resistant Jersey City population were confined continuously for seven days to pieces of vinyl, carpet, fabric, or plywood treated with the combination formulation. In this evaluation, we used Harlan bugs as a susceptible reference population. Insect mortality in dry residue assays was monitored for seven days. Groups were arranged in each trial and mortality data was adjusted with the Abbott formula.

RESULTS. The results of the various trials are shown in Figures 2 through 4. Direct sprays with Temprid had an immediate knock-down

effect with 100 percent mortality among all bed bug populations within 48 hours of exposure (Fig. 2). However, a faster mortality rate was observed in the susceptible South Carolina population and the moderately resistant KRU and Washington populations than in the highly resistant Jersey City population (Fig. 2). Trials in which bed bugs were exposed to fresh or aged deposits of Temprid in fabric or wood produced high cumulative mortality by day seven; however, cumulative mortality varied according to each population's level of resistance to pyrethroids (Fig. 3). While high levels of mortality (93 percent or higher) were observed in individuals from the susceptible Indianapolis population, mortality among the two moderately resistant populations ranged from 70 percent to 96 percent (Fig. 3). Overall, the age of the deposits did not seem to affect efficacy against bed bugs. Higher mortality was observed in Washington bed bugs exposed to deposits aged one, two or three months in wood, compared with bed bugs exposed to deposits aged in fabric (Fig. 3). Temprid deposits also caused significant mortality among KRU bugs; however, this population was generally harder to kill than the Washington population (Fig. 3).

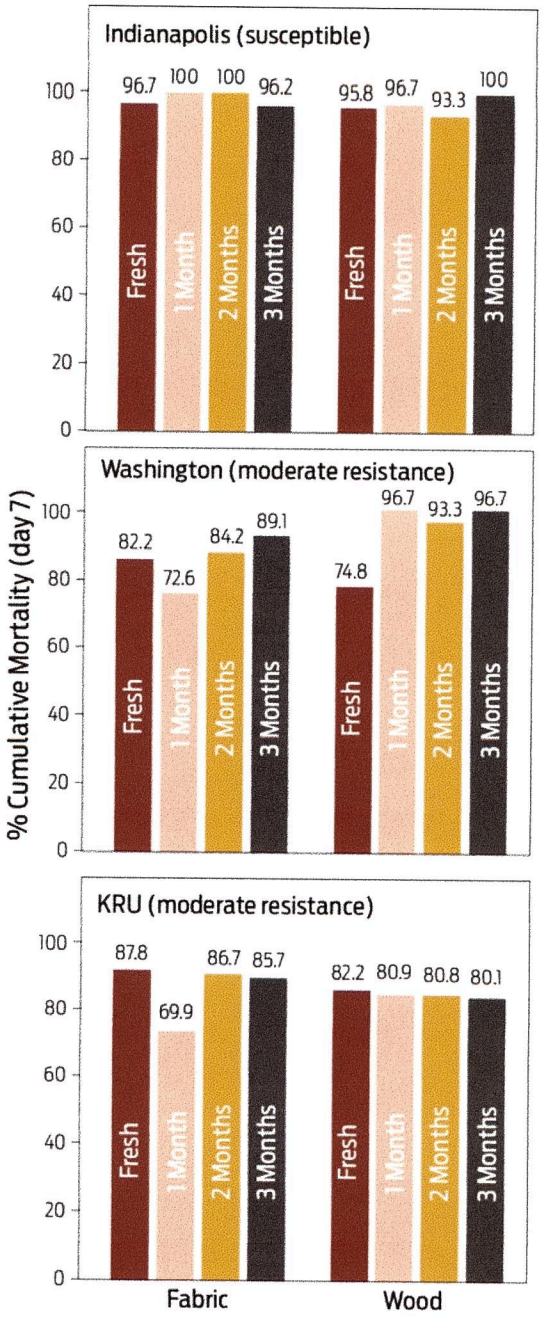


Figure 3. Lethal effect on bed bugs from different populations exposed to fresh deposits or deposits aged one, two or three months. Bugs were confined for 4 hours to fabric or wood treated with Temprid.

Efficacy of dry Temprid residues against the highly pyrethroid-resistant Jersey City population was also evaluated. Continuous exposure to surfaces containing fresh dry Temprid residues resulted in varied mortality of the Jersey City population (Fig. 4). Higher levels of mortality were observed among Jersey City bugs in Temprid-treated vinyl or carpet. However, less than a third of Jersey City bugs exposed continuously to treated fabric or wood were found dead by day seven. All susceptible Harlan populations succumbed to continuous Temprid exposure regardless of the treated substrates used (Fig. 4). These results suggest that insecticidal activity of dry Temprid deposits varies according to the surface material used.

CONCLUSIONS. Direct sprays with Temprid resulted in a higher and more rapid mortality compared with bed bugs exposed to dry Temprid residues. Direct sprays killed 100 percent of bed bugs in less than 48 hours of exposure, regardless of

pyrethroid resistance levels. Quick mortality in direct sprays may be due to greater exposure of the active ingredient than residual exposures. Rapid killing is also observed with ready-to-use materials such as Sterifab, Phantom aerosol and Temprid ready-to-spray, and it is desirable among pest control companies to quickly suppress bed bug populations. In assays with fresh residues, very high mortality rates were attained from the susceptible South Carolina population only, while some individuals from the Washington and KRU populations with moderate pyrethroid resistance were still alive after seven days post-exposure.

Temprid deposits aged for up to three months maintained their insecticidal activity against pyrethroid-resistant bed bug populations, and previous reports showed that insecticidal effects of this type of combinations may last for at least six months (Gordon et al. 2014). Long residual activity in dry residues appears to make these combinations suitable for controlling bed bugs. However, type of substrates may reduce the insecticidal activity of some of these combinations.

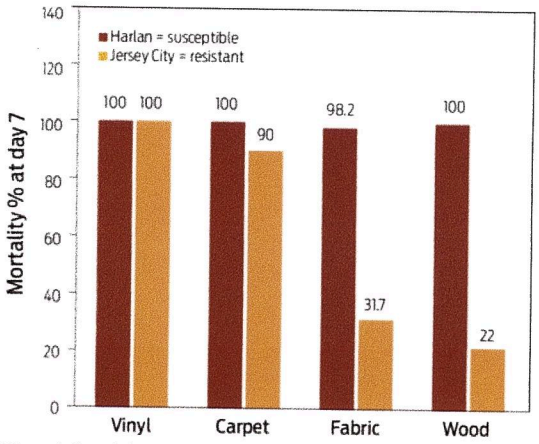
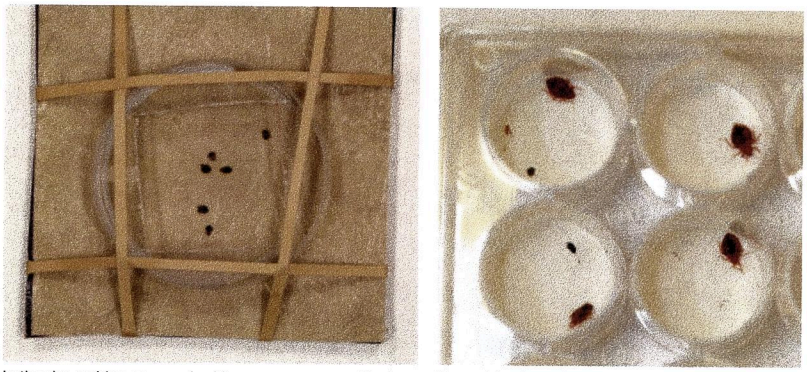


Figure 4. Cumulative mortality among susceptible and pyrethroid-resistant populations exposed continuously to dry residues of Temprid in various substrates.

Surface materials greatly affect residuality and toxic activity of insecticides to bed bugs, and much of the loss of activity is due to the migration of the insecticide into the substrate (Chadwick, 1985). In previous studies, toxicity of residues of Temprid and Tandem to bed bugs was reduced in absorptive materials (unpainted wood, fabric), while a higher toxic effect was recorded in bed bugs exposed to Transport GHP residues in the same substrates. These surface effects were seen in our trials when the highly resistant Jersey City populations were exposed continuously to Temprid residues in various substrates. Temprid deposits were more effective on nonporous synthetic surfaces such as vinyl and carpet, compared with more absorbent surfaces such as fabric and wood. Although results of Temprid in absorptive material might reduce the outcomes of treatments, there are some unperceived effects to bed bugs that might occur upon exposure to residues of this product.

In recent studies, sublethal concentra-tions of residues of Temprid placed in filter paper (an absorptive material) de-creased locomotor activity — potentially reducing bug dispersal and host seeking — interfered with a bed bug's ability to feed — potentially reducing biting activity, reduced male mating ability and reduced oviposition (Crawley et al. 2016, 2017). In addition, bed bugs did not avoid dry residues of Temprid which might lead to prolonged exposure to doses of insecticides that eventually cause sublethal effects. All above effects might complement the lethal effect produced by Temprid, thus enhancing the overall impact of Temprid treatments on bed bugs.



In the dry residue assays, bed bugs were exposed to dry residues of the insecticide continuously or for 4 hours. In the 4-hour exposure assays, bugs were transferred after exposure to clean areas to observe insecticide effects.

Although pest management professionals report via surveys that combinations are performing well in the field, there is concern about some bed bug populations with decreased susceptibility to pyrethroid/neonicotinoid combinations (Gordon et al. 2014) or various neonicoti-noid insecticides (Romero and Anderson 2016). Given the threat of increased resistance among bed bugs to current and future insecticides, early detection of infestations and incorporation of non-chemical methods (e.g., heat, steam, cold temperatures, mattress encasements, etc.) in a framework of integrated management programs, are necessary approaches for curbing the problem of bed bugs today.

Romero is professor at New Mexico State University, Las Cruces, N.M. Blakely is research assistant at the same institution. Funding for the study was provided by Bayer Environmental Science. Photos courtesy of David Mora del Pozo.

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COMMENTS