BY KRISTEN HAMPSHIRE

Mattress Matters

Research out of Ohio State finds treated liners look promising for bed bug control.

What if bed bugs stopped biting, feeding, laying eggs and reproducing? What if you could change these vital, life-sustaining behaviors that are necessary for even the most resistant populations to "make a living?"

That's what researchers explored in a study conducted at The Ohio State University and commissioned by Allergy Technologies, maker of *Active*Guard Mattress Liners, a fabric that's impregnated with the pyrethroid permethrin and designed as a long-lasting component of a bed bug Integrated Pest Management (IPM) program.

*Active*Guard is an EPA-registered product that is labeled for two-year prevention and control of bed bugs; that's an important market differentiating feature, the company says. The product serves to prevent bed bug infestations or act as a last line of defense following rigorous treatments in scenarios where PMPs are fighting large or stubborn infestations, Allergy Technologies reports.

What researchers wanted to find out is how *Active*Guard's unique formulation that provides sustained availability of permethrin — by integrating the pyrethroid with the fabric — actually impacts the bed bugs that make contact with the fiber. A recent study by Susan Jones, Ph.D., a professor in the entomology department at Ohio State, reveals that *Active*Guard interferes with the bed bug's life cycle.

The results of the study, published in the Journal of Economic Entomology, were focused on sublethal exposure time. "We wanted to see if bed bugs started showing adverse effects besides outright death after relatively short exposure times," Jones says.

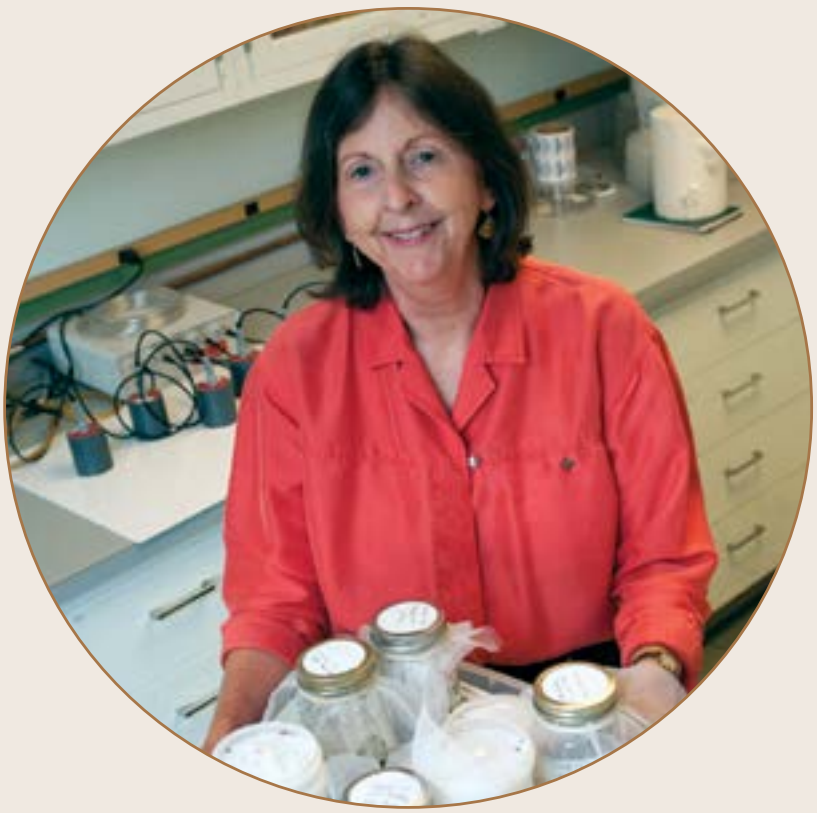
THE STUDY. In the lab, five different strains of bed bugs, from highly susceptible to extremely resistant populations, were exposed to *Active*Guard fabric for 1- and 10-minute time periods. Just 10 minutes of exposure caused bed bugs not to feed, and even after 1 minute bed bugs began to demonstrate "sublethal effects."

"You have a highly resistant bed bug that is not dead, but it is neither feeding nor laying eggs, and these are very important factors for bed bugs that are a challenge to manage," says James Ballard, Ph.D., president of Ballard Pest Management Consulting, who advises on product development for Allergy Technologies.

Is the bed bug treatment effective if the pest is still alive? Are sublethal effects sufficient for bed bug control? These are questions that PMPs might ask, since control generally is measured by killing pests, not changing their behaviors. But in fact, the impact of sublethal effects observed during this study are important to the industry because the lab results show a treatment that can impact even the most resistant strains. And if you cut off bed bugs' ability to eat and reproduce, you're essentially pulling the plug on their life support. How much longer will they last?

"If you have highly resistant bed bug populations that can't feed, that's a huge deal because all of a sudden you are impacting the winners," Ballard says. "All of a sudden, that makes resistance status a non-issue [in bed bug management]."

DELIVERING CONTROL. How does permethrin work when impregnated on *Active*Guard fabric? It changes bed bug behavior, and although researchers are not sure exactly why or how egg-laying and feeding activity is altered when bed bugs meet the treated fabric, they suspect the



"We suspect that there is a unique delivery system with the *Active*Guard fabric that allows the permethrin on the fabric to be rapidly introduced and delivered to the bug," says Susan Jones, Ph.D., a professor in the entomology department at Ohio State.

permethrin initially disorients or irritates them.

"The effect is like a bunch of drunken bed bugs trying to feed — and they don't do it well," Ballard says. "Egg production is directly related to feeding, so if there is no bloodmeal, there are no eggs. It all comes down to interfering with feeding."

Meanwhile, the way that permethrin is "presented" to bed bugs that are in contact with the fabric could actually make the pyrethroid more effective; though further research is required to confirm this. "Synthetic pyrethroids as a class are formulated in a fashion that bed bugs really don't pick them up very well," Ballard says, explaining that an insect's foot structure can vary among different types of insects. The presence of a sticky pad between each pair of claws allows for the ready pick-up of insecticides from treated surfaces.

"But bed bugs don't have those sticky pads — they are poor climbers and poor 'picker-uppers' of insecticide," Ballard continues. "So most of the pyrethroids used in the marketplace are not formulated properly for bed bugs to pick them up, with the exceptions of dusts and wettable powders that provide insecticidal particles that cling to the bed bug's body. Bed bugs simply walk over emulsifiable concentrates," Ballard says.

*Active*Guard fabric holds permethrin within its fibers so it easily can be picked up by bed bugs that are exposed to it, the manufacturer says.

This study says what's different about *Active*Guard fabric is that it holds the permethrin within the fibers so it can be picked up by bed bugs that are exposed to it. "We suspect that there is a unique delivery system with the *Active*Guard fabric that allows the permethrin on the fabric to be rapidly delivered into the bug," Jones says, referring to the lipid-rich formula that is non-chemically fixed to the fabric.

In general, Jones adds that a "formulation can make or break a product."

Ballard says the permethrin on the treated mattress liners is "able to move more effectively into the insects."

Ultimately, a treated mattress liner is not the be-all-end-all of managing bed bugs. It's not going to kill off a rampant population in a hotel. But the reduced feeding and negligible egg laying of bed bugs exposed to *Active*Guard during lab studies indicates that the fabric could serve as a practical, effective prevention tool — and as a last step in an IPM program to continue or sustain the efficacy of treatment.

The mattress liner should be placed in an inverted position on the box spring,

which typically is bed bugs' preferred harborage site during the start of an infestation, Jones says. "If we can position the *Active*Guard on box springs, that is an ideal space to first begin to impact the bed bugs," she says. "Alternatively, and particularly if no box spring is present, positioning the liner in an inverted position on the mattress may be the preferred installation configuration."

EDUCATING PMPs. Stopping the bed bug life cycle is a management technique that's just as powerful as killing them — at least that's what researchers indicate based on the study. If you have bed bugs that lose the desire to feed, they stop biting. Then they stop nesting and reproducing. And eventually, what's left?

Helping PMPs understand the importance of sublethal effects will take some education, Ballard acknowledges. Understandably, the industry traditionally has been focused on insect death as a sign of effective treatment. "With bed bugs, you need to use everything you can in your control program, and the industry is not used to products that provide levels of control that are not based on mortality," he says.

Ballard says the work Jones has performed in her lab — exposing bed bugs of various resistance ratios for certain times — illustrates the importance of sublethal time. "All of a sudden, you have a new shiny bullet out there that is working to interfere with bed bugs' feeding and egg laying, so that's pretty significant," he says.

More research is necessary to investigate the "how" of the treated mattress liners, to support the significant reductions in infestations reported when used in the field. "In the future, we plan to take the fabric into a low-income housing field situation as part of an IPM approach to see if it performs the same way," Jones says, adding that this recent study is part of a three-year grant from Allergy Technologies to gain a better understanding of how *Active*Guard works against bed bugs.

In the field, the company indicates that hotel/motel guests report no bites or few bites as a result of *Active*Guard installation. Perhaps this is explained by the findings of Jones' research study. "Using an artificial feeder with a membrane to simulate skin, we observed that the majority of bugs that had brief contact (10 minutes) with the fabric did not even try to probe the membrane or feed on blood," Jones says.

Ballard emphasizes the ability for a product to work on all strains of bed bugs, no matter how resistant, is perhaps the most critical finding of the research. "If you can overwhelm bed bugs' resistance systems, which is what *Active*Guard is likely doing, the bugs' current resistance status is less of a consideration," he says. **PCT**

The author, a freelance writer based in Cleveland, Ohio, is a frequent contributor to PCT magazine.