A Comparative Analysis of Electronic and Chemical Pest Repellent

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Abstract Recently it was argued by pest control manufacturer that repellents using high frequency sound for insect invasions are superior to the conventional chemical sprays and treatments. High frequency sound is known to repel certain insects and other animals, and permethrin is a common household pesticide also with repellent properties. It is important for the general public to know differences in repellent effectiveness and toxicity. This study compares the efficacy of the two top selling repellents, the Weitech 0615, a toxin-free high frequency sound device, and Cutter Bug Free Backyard, using permethrin. Each repellent was tested separately in backyard testing sites as prescribed on their labels. To attract nocturnal insects, a fluorescent light was set up near a white tarp. This study focuses on and analyses product failure, which is defined as the approach of an insect to the repellent-treated area. The number of these insects not repelled was tabulated as well as the insect type. The results show that both methods are effective in repelling insects compared to the area that was not treated, but the sound based product was not proved more effective than the chemical-based repellent. These findings provide some insight into the complexity of different repellent methods, and the compromises and tradeoffs involved when using synthetic chemicals versus alternative forms of repellent.

Introduction

Due to the recognized harmful effects of pesticides to wildlife as well as humans, there is a growing demand for pesticide alternatives to reduce pesticide exposure and poisoning. Alternative pest control is typically defined as a method that does not use conventional synthetic chemical compounds such as DEET, permethrin or diethyl toluamide to kill or deter insects. These alternative methods include aromatic herbal compounds like citronella, hormone sprays, and electronic sound producing devices, among others.

Purchasers often believe these forms of repellent to be family friendly, non-toxic, convenient and equally effective to synthetic pesticides, without the harm to the indoor or outdoor environments. A study by Rutgers Cooperative Extension investigated consumer concerns in regards to pesticides. Through a questionnaire, it was found that over 65% of respondents believed that synthetic pesticides had a negative effect on the environment while 25% were unsure and 10% disagreed, and of those respondents, women and households with children were more likely to be concerned with pesticide use than men and households without children. This concern for the environment and family health reflects the increasing demand for industries such as organic agriculture, and related synthetic chemical-free repellents and insecticides.

High frequency sound devices, one of the newest methods of pest control, first manufactured in 1998 by Weitech Inc., have attracted consumer attention due to their user-friendly and household safe properties. In some instances the sound output causes insect deterrence, as it resembles the high frequency sound used by nocturnal bats or other predators. This uses the animals' instincts to flee an area that is ridden with their particular predator. In other cases such as with dogs or cats, the sound may resemble that of nails on a chalkboard (Donald 2001), which will deter various animals, but as with most high frequency sound devices, are out of the typical human hearing range.

The Federal Trade Commission is investigating the claims of the manufacturers that their electronic pest control devices actually perform as advertised. If a high frequency sound repellent device can perform as claimed, the implications are increased competition for chemical repellent producers which could lead to a phasing out such insecticides if proven to be cost efficient and effective. However, data on alternative repellent use are not being collected to determine success on a comprehensive basis, making it difficult to evaluate whether, where, and

to what extent high frequency sound is actually helping to reduce the number of insects in an area or helping to reduce the amount of chemical pesticide needed.

A common pesticide is permethrin, often found in household insecticides and repellents. It is used to kill and deter insects by way of a neurotoxin which kills all life cycles of arthropods on contact. The wide use of this pyrethoid is partly owed to the fact that the Environmental Protection Agency has rendered this chemical to be of low toxicity to humans even though it has proven to be carcinogenic to lab rats (WHO 1999). Studies have also shown that it has a negative effect on wildlife such as bees and especially aquatic species (NPTN 1999).

Both sound and permethrin-based repellents have instances where animals have developed immunity. For instance, sound devices don't continue to be effective on mice longer than six months if the sound is repetitive. Additionally, Harvard University researchers found U.S. lice collected from two sites were strongly resistant to permethrin regardless of the dose. By comparison, the compound quickly killed lice collected from children in Borneo, where permethrin is almost never used as a pesticide (Natl. Post 2004).

Since most consumer information comes from the claims of individual manufacturers, it is important for the consumer to know the efficacy of the high frequency sound method in comparison to the conventional chemical sprays and the consequences of each. This research focuses on one of the most popular brands of pest control in the category of outdoor chemical treatments and outdoor high frequency sound treatments, to compare their effectiveness and check their claims through accounts of product failure. This study will address the question: Which pest control method is superior in its' repellent abilities, and which insects are best repelled by each method?

The involvement of moths in this study very important, as they are known to be positively photo tactic, and it is thought by lepidopterists (moth and butterfly scientists) that moths use light wavelengths from the moon as a navigation tool, as some moths migrate long distances nocturnally(Hsiao 2000). This actually suggests that moths aren't actually attracted to lamps, but fly to them as a navigational accident. Sound also has an effect on moths, as they commonly have an ear on each side of their thorax, tuned to intercept sound wavelengths characteristic of bat echolocation, which is often out of the normal hearing range of humans(Willis 1999).

In the case of perceived bat vocalizations, moths and perhaps other nocturnal insects would exhibit evasive behavior and flee the area in which they heard the sound (Willis 1999). These

moth characteristics make them a excellent target group for this study because moths respond to light, sound, as well as permethrin, which are all involved in this study. Although some effect is expected from each repellent, it is the instances where insects approach the repellent-treated area that are taken into account.

One hypothesis of this study is that high frequency sound will deter the most insects, causing fewer instances of insect approach compared to the permethrin-based repellent. It is also expected that moths will be more effected by high frequency sound than chemicals, therefore accounting for fewer moth identifications with the use of sound.

Methods

In order to test the question of compared efficacy, this study observes the repellent capability of each product in the backyard setting it was labeled for. A backyard setting was used during the evenings in the fall and spring months to test outdoor insect repellent treatments during times when families are most likely to use repellents. This will show us realistic results under realistic use circumstances without the extrapolation of lab data to address actual usage.

The objective of this study is to compare high frequency sound versus conventional chemical repellent in their ability to repel nocturnal insects. This study took place at two residences in Hillsborough California. 1655, and 1660 Wedgewood Dr, each being ¾ of an acre. It is a site adjacent to a large plot of open grassland belonging to the Crystal Springs Reservoir Federal Reserve. The two outdoor sites are 300 feet apart.

The sampling for the two sites used two General Electric fifty-watt compact spiral fluorescent light bulbs, two white tarps (10'x10'), one bottle of "Bug Free Backyard" by Cutter which is 2% permethrin, the amount prescribed for repellent (NPTN 1999), and one "Model 0615 Indoor/Outdoor Grade Pest Repeller" by Weitech Inc., which emits sound frequencies of the range three to forty five thousand Hz. The light bulb that was chosen was fluorescent and had a color temperature of 4000 to 5000 degrees Kelvin, as it provides white light, which attracts the most nocturnal insects by mimicking the light wavelengths of the moon. Also, the compact spiral shape of the bulb gives the best light dispersion.

The fluorescent bulb was placed in front of the tarp on a six-foot free-standing lamp post in order to attract nocturnal insects to the color as well as the light frequency (Hsaio. 2000). Directions for this product indicate that the chemical is to be sprayed onto a lawn or patio to

allow evaporation to repel insects, but for the sake of this study and to avoid contamination of subsequent research at the site, the chemical repellent sprayed over an open plastic container (12x18x4") filled half way with soil and placed on a two foot platform to allow evaporation. The Weitech sound device was introduced by placing it on a similar platform to prevent the sound from absorbing into the ground, negating the effect.

The number of insects on the tarp or within a viewable, ten to fifteen foot radius from the lamp was tabulated while recording which category the insect fits into. Insects were counted by their location on the lamp or tarp, and characterized as "Mosquito", "Moth", and "Other". Sampling took place over two hour intervals during the evening from six to eight pm. The site was sampled twelve times to establish a control. Samples were taken an additional twelve times at each site alternating between the chemical and the electronic sound device at each visit

Results

The data analyzed by a chi-square test, and reveals that the numbers of insects approaching either site were significantly different when comparing the treatment samples to the control. Comparing insect approach numbers during the Weitech sound treatment to the control sample showed that the chi-square value is 7.704, with 2 degrees of freedom and a p-value of 0.049. Analysis showed that control versus the permethrin-based repellent had a chi-square value of 3.424 with a p-value of 0.021. Comparing instances of product failure between sound and permethrin showed that there was no significant difference between the two (p-value = 0.18). The null hypothesis that there is no difference between the two methods cannot be rejected, and the sound device cannot be proven more effective than its' chemical counterpart.

	Numbers of Insects Entering Treatment Areas		
	moth	mosquito	other
control	23	47	16
sound	10	32	25
permethrin	13	11	14

Fig 1.

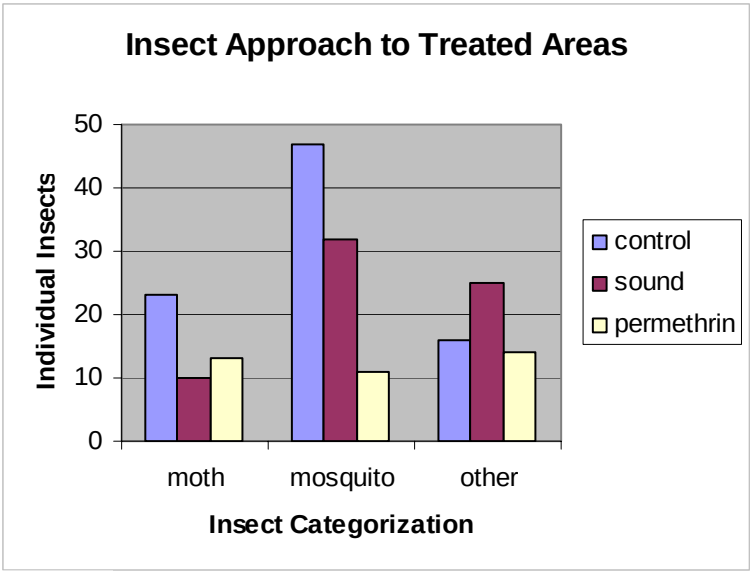

Fig 2.

Discussion

Both repellent methods claimed to be effective against all three categories of insect. As expected, there were numerous instances of product failure which constitutes an insect approaching the area despite the treatment. Both methods proved to be significantly effective in repelling insects compared to areas with no treatment. The Weitech sound device provided a 22% decrease in the overall number of insects, where permethrin provided a 56% decrease in the overall number of insects when compared to the control.

Interesting trends emerged from this study although the null hypothesis was not rejected. The presence of moths showed to be more dampened by the sonar than the permethrin. Moth numbers were decreased by 56% using sound, and decreased by 43% using permethrin-based repellent. This is an interesting avenue for further research, using only moths to test sound and chemical repellent effectiveness.

Mosquito presence also supplies interesting trends, as many consumers are most concerned with repelling these blood-sucking nuisances. Mosquitoes were reduced by 32% using sound, and 77% using permethrin. The category “other” was more difficult to interpret because it seemed that insect numbers increased by 36% with the implementation of the sound repellent, but decreased by 44% when permethrin-based repellent was used. This is another area which should be investigated in future studies, because if the trends are indeed correct, certain small

gnats and insects are attracted to certain high frequency sounds, but decrease as expected with synthetic chemical fumes.

The evaluation of sound versus chemical repellents proved to be insignificant for several possible reasons. There may have been some chemical residue remaining when sound testing was done even with the alternating of sites and extended time periods without sampling. Some bias may have been introduced through the timing of sampling, as they were from six to eight pm, and not at randomized periods of time. Weather and seasonal factors are taken into account. Rain and cold temperatures halted sampling on several occasions and caused irregular sampling days, which may have biased the data. A limitation in addition to time constraints was the lack of entomological specificity which if applied, may have provided more insightful results. For future studies, I would suggest to investigate the types of insects prevalent near the test areas.

This study represents the two spectrums of insect repellent, the conventional and the alternative. This study shows that when using high frequency sound there is increased security from worrisome toxic fumes and possible physical reactions that are characteristic of exposures to synthetic biocides. But with this increased sense of security, the alternative sound method also has its limitations. Like chemicals, high frequency sound can be misused and result in pests that are immune to the treatment. This study reinforces the idea that non-toxic alternatives which are safer to use in households contain a tradeoff in effectiveness for that added security. This dismissal of non-chemical methods of repellent and pest control is not to be taken lightly, because any movement away from the dominant use of synthetic biocides is beneficial to our environment and consequently to us.

Acknowledgements

I would like to thank Stacy and Aaron Ausberry, who sacrificed many evenings without complaint to help complete this study.

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