

Prevention and Deterrence of *Solenopsis invicta* (Hymenoptera: Formicidae) in Household Environments

Texas A&M University, Department of Entomology

Barbara Brocard

Editor: Alexis Sterling

Abstract. Red imported fire ants (*Solenopsis invicta*) are an invasive species in the U.S. that have spread and infested millions of acres of land in the southeastern states. If disturbed they will readily sting humans and animals, leading to a range of systematic reactions and in some cases anaphylactic shock (Simothy, 2018). However, red imported fire ants do serve as a natural biological control to arthropod vectors of diseases. This article documents the effect of three deterrents and their ability to prevent the infestation of homes with red imported fire ants, while at the same time keep them alive to continue to serve as a natural biological threat. Each test had an initial total of twenty ants and the deterrents used were Raid, lemongrass essential oil, and peppermint essential oil. All three deterrents worked effectively in preventing the opportunity for infestation with Raid being the most effective, allowing only two ants to cross. Lemongrass essential oil was the least effective, allowing twelve ants to cross. However, Raid was also the most effective in killing the ants with all twenty being killed in comparison to lemongrass essential oil which only killed twelve ants. With this invasive species continually expanding, lemongrass essential oil would be the best deterrent to use, without killing the ants.

Key Words. Medical Entomology, Pest control, clinical, *Solenopsis invicta*, Raid, Lemon essential oil, peppermint essential oil.

Solenopsis invicta, also known as the Red Imported Fire Ant, first arrived in the United States via accidental introduction sometime during the 1930s and 40s (Collins 2016). Native to South America, this species is a well-known pest throughout the globe. These ants are easily identifiable from their red color, small size, and moderately sized ant mounds. Fire ants are considered a pest species, capable of stinging victims leading to allergic reactions or finding their way

inside homes in search of a food source. While some dismiss these ants only as a nuisance, in reality they can prevent the spread of some diseases through the elimination of vectors for pathogens. Although they are capable of reducing the population of vectors of some diseases, they are also able to mechanically vector foodborne illnesses by tracking in pathogens from going in and out of a source (Mahomoodally 2018). These are two ends

of the spectrum of abilities that ants have and is the reason that this study is being conducted. The purpose is to discover a method that allows for the prevention of ants inside homes, but at the same time does not eliminate the ants and allows them to prosper on outside sources so they can remain as helpful agents in reducing the spread of certain diseases (Castellanos 2016). Raid is a well-known insecticide and is used in the complete elimination of these insects. This substance will be used to determine if the ants themselves can be deterred from an area without killing them as tested in previous studies (Jaafar 2018). Lemongrass and peppermint essential oils have also been used in previous studies; however, they were introduced in a household pesticide environment to kill the ants, so the inclusion of deterrence in addition to the elimination study will allow for additional information to be included in the household remedy studies (Tramut, 2013).

Materials and Methods

This experiment was performed with *Solenopsis invicta*, commonly known as the Red Imported Fire Ant. *Solenopsis invicta* were collected in the wild and placed into one of four separate boxes. Each box consisted of the same major components: a space in which the *Solenopsis invicta* were initially placed, a food source, and a chemical barrier applied between the two. Food sources were placed in weigh boats so that their masses could be collected before and after testing to determine whether or not *Solenopsis invicta* had crossed the barrier without detection. Chemical barriers for this

experiment include Lemongrass essential oil, Peppermint essential oil, and a commercial ant preventative/insecticide, Raid. The fourth experimental box was used as a control, with no barrier applied. Using action cameras powered by an external source, the activity and behaviors of *Solenopsis invicta* were recorded and compared with respect to different variables. These variables included the amount of sugar that was removed from the source each week, the number of *Solenopsis invicta* to have crossed over to the food, the number of dead *Solenopsis invicta*, and the amount of time it took for a group of *Solenopsis invicta* to cross the barrier. Over time, the groups eventually began to cross the barrier provided in search of food. The time it took for a group to cross the barrier was used to determine the comparative effectiveness of the chemical barriers. In addition to the cameras constantly recording the progress of the different experimental groups, each box was checked on Tuesdays and Fridays over the course of the observation period. Even though *Solenopsis invicta* samples were obtained in the local environment, they are still an invasive species. Because of this, those remaining at the conclusion of the experiment were eliminated using a commercial insecticide.

Results

In total, 80 ants were collected from the wild and tested in this experiment, with 20 ants being tested per independent variable. Data was collected over the dependent variables; number of ants crossing the barrier, number of ants dead, and the amount of time it took for an initial group of ants to cross over the

barrier (in minutes). No barrier entirely prevented ants from crossing over, but they did provide different levels of prevention. The most effective treatment in terms of number of ants crossing was Raid, with only 2 ants crossing compared to every other treatment allowing over 10 ants each.

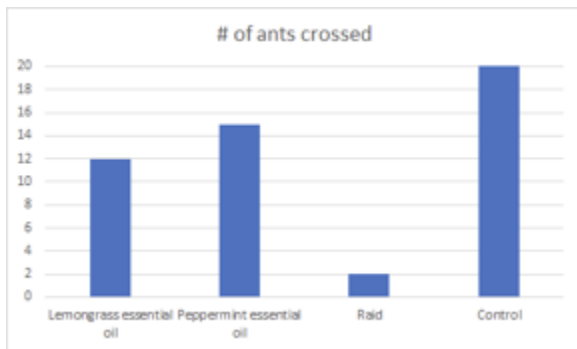


Figure 1. The number of ants that crossed.

Treatments also differed in the number of ants dead. Raid was found to be the most lethal treatment, resulting in the death of all 20 ants. Both essential oil tests were also found to be deadly, with the lemongrass resulting in 12 deaths and 15 deaths for the peppermint essential oil.

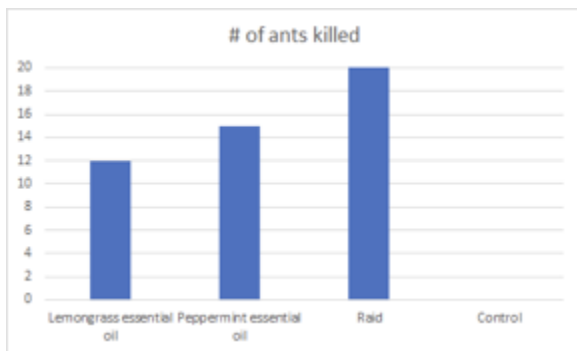


Figure 2. The number of ants killed in this experiment.

Raid was found to be the most effective preventative barrier with the ants taking 7 minutes to cross, followed by peppermint

essential oil and lemongrass essential oil with 5 and 3 minutes to cross respectively.

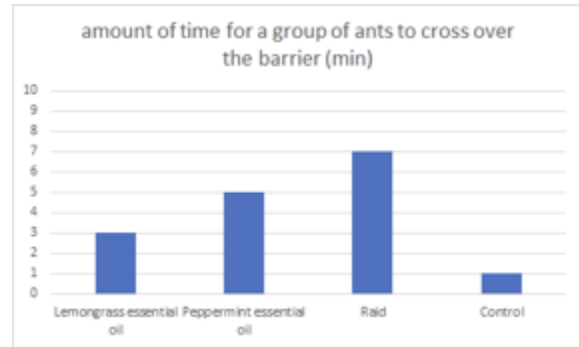


Figure 3. The amount of time for ants to cross the barrier, in minutes.

Discussion

Solenopsis invicta is an exceedingly common pest across the United States, and can be a physical threat to both animals and humans. Aside from inflicting a painful sting, they can be vectors of pathogens which can contaminate food, food-contact surfaces, and water (Simothy et al. 2018). Even their bites can produce severe reactions in people with allergies to fire ants, including anaphylaxis, skin irritation, dyspnea, hives, unresponsiveness, and many other symptoms (Klotz et al. 2005). Ants have even become a common nuisance in hospital environments, where they potentially pose an even larger threat to human health (Lutinski et al. 2015). They are among the organisms best adapted to living in urban environments (Lutinski et al. 2015), where humans must regularly come into contact with them. In consideration of these factors, it is important for the public to understand the most effective ways in which they can protect themselves from these widespread pests. The present study examines the effects of lemongrass essential oil, peppermint essential oil, and the commercial product, Raid, on the deterrence

of *Solenopsis invicta*. Additionally, the data represents the amount of ants killed by each substance. As presented in the results section, Raid was found to be the most effective preventative barrier, with less ants crossing and more ant deaths than any other test group. When peppermint essential oil was used as the barrier, it resulted in many more ants crossing the barrier than with Raid, but slightly fewer ant deaths. When lemongrass essential oil was used, the results indicated that the number of ants crossing the barrier was in between that of the Raid and peppermint oil. The number of ant deaths was the lowest for this group out of any of the groups. Although the use of Raid as a barrier experimentally showed the most drastic results in regards to effectiveness at deterring and killing ants, it may not be the most favorable method for use in the real world. The presence of *Solenopsis invicta* populations in an ecosystem may be linked to decreased rates of pathogen transmission, in accordance with the dilution effect hypothesis (Castellanos et al. 2016). This hypothesis suggests that ecological biodiversity limits the spread of disease. For example, one study proposed that the invasion of imported red fire ants resulted in a decreased abundance of small mammals, either associated with predation or avoidance behavior (Castellanos et al. 2016). The data from this study showed that reduced small mammal populations served to control local tick populations. This decrease in tick abundance could result in decreased transmission of tick-borne pathogens (Castellanos et al. 2016), which are a major public health concern. For this reason, it

may be more favorable to use a fire ant deterrent that will not only effectively prevent the insects from entering places inhabited by humans, but also will allow for maintenance of a healthy population of *Solenopsis invicta*. Raid is deadly to ants because it contains the substance cypermethrin, which shuts down the nervous system's ion channels following contact or ingestion (Jaafar et al. 2018). In contrast, plant essential oils have been shown to mainly disrupt the foraging behavior of fire ants. Compared to traditional pesticides, plant essential oils can serve as environmentally friendly alternatives because they are typically safer and less toxic to humans and domestic animals. Additionally, they are more readily degraded in the environment (Wang et al. 2014). Overall, the lemongrass essential oil was the most effective deterrent of *Solenopsis invicta*, which proved to be non-lethal to the experimental ant population, and possesses multiple benefits over traditional pesticides such as Raid.

Conclusion

The performed study included a mix of variables that allowed for conclusions to be drawn and a possibility for further educational research to be conducted on the topic. The number of starting ants remained constant in each trial in order to obtain more consistent, higher quality results. The number of deaths was desired to be minimal, while keeping the number of ants crossing the chemical barrier as low as possible as well. Although lemongrass was the most effective at providing the sought out results of this study, a further study should be done with more variables. The intended goal of

the research was to keep the pests out of a designated area, but not eliminate them at the same time because of their benefits to the environment. When exploring the possibilities for further conclusions to be drawn with a more effective protectant, extensive research should be conducted to allow for a longer life span of the ants, in addition to chemical compounds that restrain them from entering a desired location.

References

Baldacchino, F., Tramut, C., Salem, A., Liénard, E., Delétré, E., Franc, M., ... Jay-Robert, P. 2013. The repellency of lemongrass oil against stable flies, tested using video tracking. *PARASITE*. 20: 21.

Castellanos, A. A., Medeiros, M. C., Hamer, G. L., Morrow, M. E., Eubanks, M. D., Teel, P. D., ... & Light, J. E. 2016. Decreased small mammal and on-host tick abundance in association with invasive red imported fire ants (*Solenopsis invicta*). *Biology letters*, 12(9), 20160463.

Collins, L., & Scheffrahn, R. H. 2016.. Red Imported Fire Ants. Retrieved February 23, 2020, from http://entnemdept.ufl.edu/creatures/urban/ants/red_imported_fire_ant.htm

Jaafar, J., Kerns, D., Palacios, K., Osegueda, M., Tomaszewicz, P., Palacios, S., Smith, S., and Escalon, V. 2002. Efficacy of Professional and Homemade Residual Pesticides on *Solenopsis invicta* (Hymenoptera: Formicidae) 20: 18-19.

Klotz, J. H., Deshazo, R. D., Pinnas, J. L., Frishman, A. M., Schmidt, J. O., Suiter, D. R., ... Klotz, S. A. 2005. Adverse reactions to ants other than imported fire ants. *ANNALS OF ALLERGY ASTHMA & IMMUN*.95: 418–425.

Lutinski, J. A., Ahlert, C. C., de Freitas, B. R., Trautmann, M. M., Tancredo, S. P., & Mello Garcia, F. R. 2015.. Ants (Hymenoptera: Formicidae) in hospitals of southern Brazil. *REVISTA COULOMB DE ENTO*. 41: 235-240.

Simothy, L., Mahomoodally, F., & Neetoo, H. 2018. A study on the potential of ants to act as vectors of foodborne pathogens. *AIMS MICROBIOL.* 42: 319–333.

Tang, L., Sun, Y.-Y., Zhang, Q -P., Zhou, Y., Zhang, N., & Zhang, Z. -X 2013. Fumigant Activity of Eight Plant Essential Oils Against Workers of Red Imported Fire Ant, *Solenopsis invicta*. *SOCIOBIOL.* 60: 35-40

Tiago Falótico, Marcelo B. Labruna, Michele P. Verderane, Briseida D. De resende, Patrícia Izar, Eduardo B. Ottoni. 2018. Repellent Efficacy of Formic Acid and the Abdominal Secretion of Carpenter Ants (Hymenoptera: Formicidae) Against *Amblyomma* Ticks (Acari: Ixodidae) , *JOR OF MED ENTO.* 26: 718–721.

Wagan, T. A., Chakira, H., He, Y., Zhao, J., Long, M., & Hua, H. 2016. Repellency of Two Essential Oils to *Monomorium pharaonis* (Hymenoptera: Formicidae). *FLORIDA ENTO.* 99: 608–615.

Wang, J., Qiu, X., Zeng, L., & Xu, Y. 2014. Interference of Plant Essential Oils on the Foraging Behavior of *Solenopsis Invicta* (Hymenoptera: Formicidae). *FLORIDA ENTO.* 97: 454-460.