

Effects of Peppermint Oil and Vinegar on Killing and Preventing the Red Imported Fire Ant, *Solenopsis invicta* (Hymenoptera: Formicidae) in Households

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Edited by: Anchal Thomas

Abstract: *Solenopsis invicta* (fire ants) have only been present in the United States for approximately 75 years, but have proven not only to cause annoyance but also cause fear within the human population. In an attempt to decrease this nuisance, two different substances were tested for their effectiveness in terminating these fire ants. The fire ants were collected in College Station, Texas, and the substances tested included peppermint oil and vinegar. After experimentation, it was found that peppermint oil was overwhelmingly more effective than vinegar, especially when the oil was present in very high concentrations.

Key Words: *Solenopsis invicta*, fire ants, peppermint oil, vinegar, pesticide

Since *Solenopsis invicta* (fire ants) were first introduced to the United States 75 years ago, these little insects have forced a significant amount of attention onto themselves due to the frustration and annoyance they cause human beings. Not only do these arthropods cause irritation for the human population, but they also cause panic. They have been proven to be lethal when encountered in large numbers (Vison 1997). The “homegrown” pesticides tested in this experiment targeted the less severe cases during which ants typically cause annoyance. This study aims to help by finding a method to kill these invaders in the home, without using pesticides that could potentially cause

harm to the environment and other living organisms present such as children and pets. Ants are known to be very social creatures, so where there is one, there are sure to be more on the way. Ants leave a pheromone trail so their nest-mates are able to find their way to the food as well (Segelken 1998). Pheromones are one of several ways that ants communicate with one another. Receptors located on the antennae of ants detect the pheromones released by their nest-mates. This is why ants are often found crawling one after another in a line. They are following the pheromone trail left by their nest-mates. It was hypothesized that pesticides with a strong odor will help deter ants from entering

households because the strong odor will interfere with the pheromones released by other ants. The household items that were tested on the collected fire ant specimens as pesticides are peppermint oil and vinegar. Both are known to have very strong, distinct odors. This experiment tested the efficiency of each pesticide and also helped determine how fire ants respond to different pesticides when they are in the vicinity of each pesticide.

Material and Methods

Methods for Collecting *Solenopsis invicta*.

An ant pooter (Gempler's, Janesville, WI), or aspirator, was used to isolate ants from the *Solenopsis invicta* ant piles in College Station. The ants were aspirated into a glass capsule vial (Bioquip, Rancho Dominguez, CA). Ants were collected from around the ant pile, instead of directly from the antpile to reduce amount of soil collected. Approximately 2,000 ants were collected total. The ants were then separated from any dirt that may have also been collected and divided into groups of 25.

Methods for Efficiency of Peppermint Oil and Vinegar in Killing *Solenopsis invicta*.

Various concentrations of peppermint oil (Bulk Apothecary, Aurora, Ohio) and vinegar (The Vinegar Institute, Atlanta, GA) were used to test the effect of homemade pesticides on killing *Solenopsis invicta* (fire

ants). In the experiment, 3 mL of 100% vinegar or peppermint oil, 3 mL of 50% vinegar or peppermint oil, or 3 mL of 25% of vinegar or peppermint oil were poured into a petri dish (Bioquip, Rancho Dominguez, CA). Thirteen red imported fire ants were then added to each petri dish and observed for two minutes. This was conducted three times with vinegar and three times with peppermint oil. The data was collected by counting the number of ants that were not moving and were therefore considered dead. This number was then put over the total number of ants in the trail and a percent of effectiveness was generated. The more dead ants there were, the more effective the pesticide was.

Methods for Efficiency of Peppermint Oil and Vinegar in Preventing *Solenopsis invicta* invasion.

In this study, the ants were surrounded with either 100% vinegar or 100% peppermint oil in 3 different formations. The first formation was a rectangle with dimensions 10.88 inches by 8.16 inches. The second formation was a rectangle with similar dimensions but a 1.36 inch gap was left on the long edge. The third formation had the same dimensions as well, but a 2.72 inch gap was left on the long edge. Fifteen ants were placed in each formation and the amount of time taken to exit the formation was recorded. A limit of 30 minutes was set for each trial. The number of ants that passed through the border or gap were recorded. Three trials were conducted.

Results

Results of the Efficiency of Peppermint Oil and Vinegar in Killing *Solenopsis invicta*.

Trial 1			Trial 2			Trial 3		
	Ants Dead	Ants Alive		Ants Dead	Ants Alive		Ants Dead	Ants Alive
100% Vinegar	3	12	100% Vinegar	2	13	100% Vinegar	2	13
50% Vinegar	1	14	50% Vinegar	1	14	50% Vinegar	1	14
25% Vinegar	1	14	25% Vinegar	0	15	25% Vinegar	1	14
100% Peppermint Oil	13	2	100% Peppermint Oil	15	0	100% Peppermint Oil	15	0
50% Peppermint Oil	12	3	50% Peppermint Oil	13	2	50% Peppermint Oil	12	3
25% Peppermint Oil	9	6	25% Peppermint Oil	9	6	25% Peppermint Oil	7	8

Fig 1: These figures represent the data collected during all three trials which explain the efficiency of peppermint oil and vinegar. This data represents how many ants were alive and how many ants were dead at the end of two minutes.

There were a total of 90 ants used in each trial. The data collected during each of the trials is displayed in Figure 1, shown above. The results show that peppermint oil was more effective than vinegar in killing *Solenopsis invicta* ants in all three trials.

While vinegar was less effective than peppermint oil, it still killed some of the ants. The 100% vinegar concentration was more successful in killing more ants than the diluted vinegar concentrations.

Results of the Efficiency of Peppermint Oil in Preventing *Solenopsis invicta* invasion.

Trial 1

	10 min	20 min	30 min	
All sides closed	4 ants	6 ants	5 ants	Through the border
1.36 inch gap on the left edge	2 ants	4 ants	1 ant	Through the border
1.36 inch gap on the left edge	2 ants	3 ants	3 ants	Through the gap
2.72 inch gap on the edge	2 ants	0	0	Through the border
2.72 inch gap on the edge	3 ants	5 ants	5 ants	Through the gap

Trial 2

	10 min	20 min	30 min	
All sides closed	3 ants	4 ants	8 ants	Through the border
1.36 inch gap on the left edge	3 ants	0	2 ants	Through the border
1.36 inch gap on the left edge	3 ants	4 ants	3 ants	Through the gap
2.72 inch gap on the left edge	1 ant	2 ants	0	Through the border
2.72 inch gap on the left edge	2 ants	6 ants	4 ants	Through the gap

Trial 3

	10 min	20 min	30 min	
All sides closed	3 ants	5 ants	7 ants	Through the border
1.36 inch gap on the left edge	3 ants	0	0	Through the border
1.36 inch gap on the left edge	0	5 ants	7 ants	Through the gap
2.72 inch gap on the left edge	0	0	0	Through the border
2.72 inch gap on the left edge	3 ants	5 ants	7 ants	Through the gap

Fig. 2: These figures represent the efficiency of peppermint oil in preventing *Solenopsis invicta* invasion during three trials.

There were a total of 75 ants used in each trial. In each trial, once the ants were placed in the rectangle of peppermint oil, they crawled up to the oil and then would back away. This was done until the ant finally decided to go through the peppermint oil. Figure 2, shown above, displays explains how many ants were present in the rectangle at the time intervals of 10 minutes, 20 minutes, and 30 minutes, the number of ants that escaped through the border, and the number of ants that escaped through the gap, if one was present. The results show that more ants preferred escaping through a gap, if present. If a gap was not present, some ants reluctantly crossed the peppermint oil border. Others remained in the rectangles, continually going to the border and back towards the center of the rectangle.

Discussion

The data collected by this study shows that peppermint oil was able to effectively kill *Solenopsis invicta* and serve as a good preventative method in stopping them from entering or exiting specific places with a border of peppermint oil. The reason this substance was more effective than vinegar remains unclear. It is not known whether the potent odor played any significant role in actually exterminating the specimens or if it was a specific compound found in the peppermint oil itself, such as a chemical component or a physical property like the thicker consistency of the oil, which was ultimately the reason for their deaths. Like peppermint oil, the vinegar used had a strong odor. When the vinegar was tested, it had an effect on the ants by slowing them down. Although it did not kill them, the vinegar seemed to just be a nuisance to the collected specimens, causing them to decrease in speed and activity or stay still.

The vinegar did not completely stop the ants from crossing the border that was made, but it did to some extent decrease the number of the ants that crossed. Overall, the vinegar proved to be virtually ineffective in killing the ants, but was generally successful in disorientating them.

The three trials that took place where the ants were surrounded in a line of vinegar or peppermint oil, with only a small gap dry where the ants could get out of the circle without having to go through the substance being tested confirmed the suspected reliability of the “homemade” pesticides. The first substance tested was the peppermint oil. The ants within the almost closed circle seemed to avoid the oil line at all cost. Almost all of the ants followed the line around the “C” shape until they found the opening. The few disoriented ants that remained were unable to find the opening and passed through the 2 inches-wide line of oil. Since the odor of the oil is extremely disliked by the ants, it took those remaining a decent amount of time to get to the other side of the oil line. The results were similar for the other two trials of this specific part of the experiment. When the ants were mostly surrounded with the vinegar, many of the ants were disoriented due to the diminishing of the pheromones temporarily, but eventually the vinegar evaporated for the most part, and the insects within the “C” shape were then able to leave rather quickly, whether it be over the partial line of vinegar or through the gap in the substance circle.

While testing the invasion prevention method the fire ants were less willing to cross the border of peppermint oil. Although the peppermint oil did not detour every specimen from crossing, it did significantly reduce the speed at which the ant traveled through the peppermint oil perimeter. The fire ants seemed to be in a disabled state even after successfully crossing through the border.

The other method in this experiment was observing how the ants reacted in different concentrations of peppermint oil or vinegar. The experiment could have been more successful if the containers used had completely flat bottoms. The plastic petri dishes used prevented the ants from moving anywhere besides the middle raised section. This lack of space for the insects to move could have resulted in partially inaccurate data when it came to the calculation of how effective the peppermint oil or the vinegar were at killing the ants, because it is not completely clear whether the ants died because of the substances being tested or because the specimens just drowned.

It has been determined that the peppermint oil was more successful than vinegar in killing the collected fire ant specimens and preventing them from entering an area. The vinegar does have a distinct odor that will cause the ants to be

disoriented, which is a state the insects were to remain in until the surrounding vinegar is dissolved and the ants were then able to continue. The vinegar is a decent temporary solution to prevent ants, especially for those who do not wish to kill the insects. The peppermint oil was a much better solution to the search for a “homemade” pesticide due to its higher efficiency in deterring the fire ants with its potent odor. The potent odor of the peppermint oil was able to completely block the pheromones and cause the ants to avoid any area that contained the peppermint oil.

Acknowledgement

Special thank you to Dr. Adrienne Brundage and Taylor Donaldson in the Medical Entomology Department at Texas A&M University for providing us the entomology knowledge and the equipment to complete this experiment.

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