Evaluation of Neem Oil and Insecticidal Soap As Individual Mound Treatments for Red Imported Fire Ants

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In Texas, there is a growing interest in using naturally derived insecticides for controlling all insects, including red imported fire ants, *Solenopsis invicta* Buren (Hymenoptera: Formicidae). These products are termed "organic" (Drees and Lennon 1998). Current organic recommendations for control of other landscape insects include neem oil and insecticidal soaps, for such pests as scales, aphids, leafhoppers, and thrips. However, it is not labeled for use on fire ant mounds.

Both insecticidal soap and neem oils are suffocating insecticides, so the insect must come into contact with the soap or oil in order to cause death. Insecticidal soap has the active ingredient of potassium salts of fatty acids. The fatty acids disrupt the structure and permeability of the insects' cell membranes. This causes the cell contents to seep out, so the insect dies quickly. Natural neem oil is removed from the seeds and treated with alcohol, so almost all of the azadirachtin and related substances separate from the oil. The oil is then called clarified hydrophobic extract of neem oil. This oil coats and suffocates insects after contact. D-limonene is an extract derived from citrus peel, which causes abnormal activity to the insects' sensory and nervous systems. After contact, this chemical compound causes the insect to twitch, convulse and become paralyzed.

For this trial, we wanted to evaluate the effectiveness of neem oil and insecticidal soap on eliminating fire ant mounds, compared to the effective organic killing agent d-limonene (Engler et al 2005). The following treatments were evaluated for killing fire ants: neem oil (70% clarified hydrophobic extract of neem oil), insecticidal soap (47% potassium salts of fatty acids) and d-limonene (78.2% d-limonene).

Materials and Methods

On September 27, 2006, an area of 10 acres surrounding the Gerik homestead in Whitney, TX was divided into five strips measuring 50-feet wide. The temperature was 75° F with winds 20-30 mph. Two surveying flags were placed on either side of the strip after locating and flagging 10 active mounds. Flags were also placed along both edges of the plots, to delineate the boundaries of each plot. A 12 foot wide buffer was placed between strips to prevent effects of treatments from affecting fire ant colonies in adjacent plots.

A total of 16 plots were measured (Figure 1). Plot lengths were arrayed from shortest to longest, then divided into 4 blocks containing 4 treatment plots each. This allowed the total length of plots for all the treatment plots to be roughly equal, so colony migration into and out of the plot areas was similar for all treatments. Within each treatment block, treatments were assigned to plots at random and to minimize pre-treatment differences in total plot length (Table 1).

Treatments were applied in the morning on September 28, 2006. Skies were clear and the temperature was 77° F with winds 0-5 mph. The treatments placed on each mound included:

1) Water treatment (1 gallon)
2) Green Light® Neem Concentrate (2 tablespoons per gallon of water)
3) Garden Safe™ Insecticidal Soap Concentrate (4 tablespoons and 2 teaspoons per gallon of water)
4) Safer® Brand Fire Ant Killer (4 tablespoons per gallon of water)

Evaluations were made at 3, 10, 17, 24, 31, 38, 45 and 52 days post-treatment. Evaluations were conducted by dropping pieces of hot dogs onto the flagged mounds and then evaluating activity after 1 hour. This evaluation was chosen due to the lack of rain during the summer. Also the number of red imported fire ants were rated on a scale from 1-5, with 1=0-25 fire ants, 2= 25-50 fire ants, 3= 50-100 fire ants, 4= 100-200 fire ants and 5= 200+ fire ants. This rating system was used to estimate the number of fire ants within the colony. Data were analyzed using SPSS Analysis of Variance (ANOVA) test with means separated using Duncan's Multiple Range Test at $P \leq 0.05$ (SPSS for Windows, Lead Technologies, Version 13.0).

Results and Discussion

Three days after treatment, d-limonene, insecticidal soap and neem oil had significantly fewer mounds than the water control (Table 2). At 10, 17, 24, 31, and 38 days there were no significant differences found between the treatments and water control. At 45 days, d-limonene had significantly fewer mounds than neem oil, insecticidal soap and water control. At 52 days, there were no significant differences found between the treatments and the water control. Overall, the d-limonene drench eliminated the most fire ant mounds at the beginning of the experiment and continued to show a decrease in mound activity throughout the trial, except at 24 days. The plots treated with neem oil had fewer active fire ant mounds compared to insecticidal soap and water controls. Even though the neem oil was not significantly different than insecticidal soap or water control, it did eliminate more fire ant mounds within the trial.

Results from rating the amount of fire ants on hot dog slices showed a significantly higher number of fire ants in the water control than all other treatments at three days (Table 3). However at 10, 17, 24, 31, 38, 45 and 52 days, there were no significance differences between the number of fire ants in the treatments and the water control. Even though not significant, d-limonene treated mounds had a lower number of fire ants found on the hot dog slices than the other treatments and water control.

Surveys of the total number of ant mounds per plot documented no relocation of mounds found within any of the plots. This data indicates that the insecticide treatments eliminated the colonies, instead of causing them to relocate. This is valuable information to tell consumers since the treatments eliminated the fire ant colony, rather then moving them to another location.

The data collected did not indicate a significant difference in effectiveness between the water control and the three organic treatments for most of the monitoring period. Even though not significant, d-limonene eliminated more fire ant colonies in this test. However the d-limonene treatment is more expensive, more labor intensive and time consuming compared to

applying other treatments such as dust or bait formulated products to individual fire ant mounds.

Since the plots were suspected of containing polygene colonies, a limiting factor of the individual mound treatments was the possibility of not killing all the queens with one application. Perhaps the treatments should have been applied on a weekly or bimonthly basis to contact all queens within the colony, in order to eliminate the colony. Also since surface activity was minimal, applying only a gallon of water might have not reached the deeper nesting brood or queens. If the fire ants were nesting closer to the soil surface, results may have been different. Future trials will be scheduled to evaluate these factors.

The decline of activity seen in the water controls is possibly due to the severely dry conditions experienced in North Texas from May through October. This caused the observations to have high variability between treatments which could have hindered separation of means between treatments. Although we were able to detect trends, statistical differences were minimal between treatments. Perhaps if more rain occurred before and during the trial, our results would have differed.

Figure 1. Plot plan for candidate **"**organic" individual mound treatments for fire ants on the Gerik Estate, Hill County, TX initiated on September 27, 2006 by treating 10 individual mounds within each plot with neem oil, insecticidal soap, d-limonene, or water.

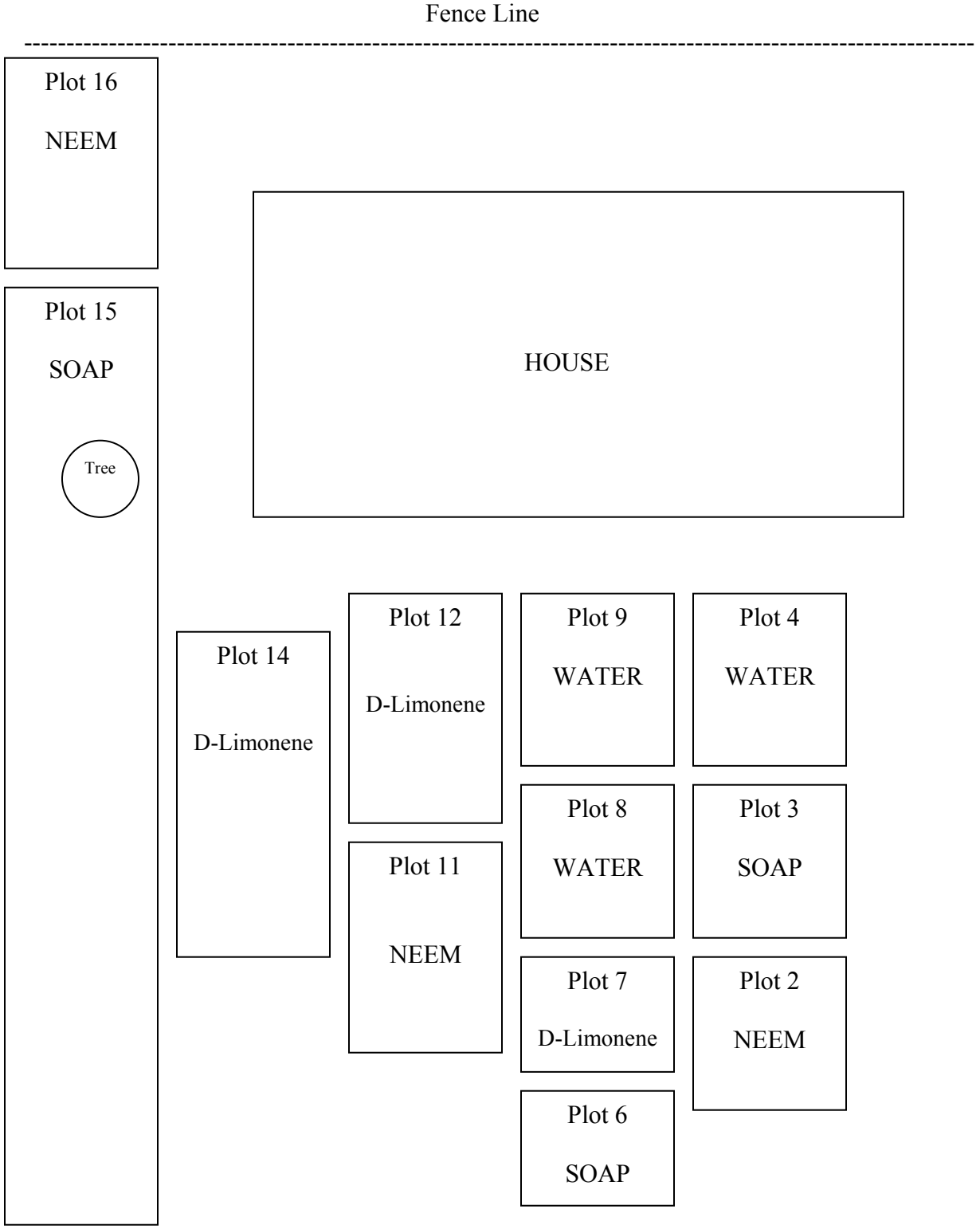

Table 1. Treatment block assignments based upon plot length.

Block and Plot Number	Plot Length (ft)/10 mounds	Treatment
7, 10, 12, 14	55, 48, 97, 54	D-limonene
2, 11, 13, 16	53, 52, 97, 55	Neem Oil
3, 5, 6, 15	45, 17, 46, 147	Insecticidal Soap
1, 4, 8, 9	73, 64, 60, 58	Water Control

Table 2. Mean number of active red imported fire ant mounds found in Whitney, TX.

Treatment	Precounts	3 Days	10 Days	17 Days	24 Days	31 Days	38 Days	45 Days	52 Days
D-Limonene	10.00a	3.50a	3.25a	2.75a	8.75a	7.00a	4.00a	4.25a	4.25a
Neem Oil	10.00a	6.75ab	4.00a	4.00a	6.00a	7.25a	5.00a	6.25ab	4.25a
Insecticidal Soap	10.00a	6.25a	4.25a	4.25a	6.75a	7.75a	5.25a	7.50**b**	6.50a
Water Control	10.00a	10.00**b**	4.50a	4.50a	7.00a	6.75a	6.00a	7.50**b**	7.50**a**

[a]Means followed by the same letter within the same column were not significantly different using Analysis of Variance (ANOVA) and means separated using Duncan's Multiple Range Test at $p \leq 0.05$ (SPSS, Windows 11.5).

Table 3. Rating of fire ants found on a hot dog slice on each mound in Whitney, TX.

Treatment	3 Days	10 Days	17 Days	24 Days	31 Days	38 Days	45 Days	52 Days
D-Limonene	0.80a	0.75a	0.63a	2.10a	1.50a	0.78a	1.00a	3.23a
Neem Oil	2.33a	0.93a	0.93a	1.40a	1.88a	1.08a	1.55a	2.54a
Insecticidal Soap	2.43a	1.25a	1.25a	1.28a	1.88a	1.25a	2.13a	3.36a
Water Control	4.25**b**	1.53a	1.53a	1.85a	1.93a	1.18a	2.18a	3.39a

[a]Means followed by the same letter within the same column were not significantly different using Analysis of Variance (ANOVA) and means separated using Duncan's Multiple Range Test at $p \leq 0.05$ (SPSS, Windows 11.5).

Literature Cited

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