Evaluation of Organic™ Solutions All Crop Multipurpose Commercial and Agricultural Insecticide as a Red Imported Fire Ant Mound Drench Treatment

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The red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), is a major economic pest in Texas. Surveys conducted by the Department of Agricultural Economics and the Texas Agricultural Statistics Service have estimated the total annual fire ant damages and expenditures for Texas to be 1.2 billion dollars.

Objective: This trial evaluated five currently available mound treatments to control red imported fire ant colonies in a controlled, replicated field test.

Materials and Methods

This trial was established on the Ingram Ranch in northern Comal County approximately 45 miles north of San Antonio, Texas on November 1, 2002. The treatment area was located at the eastern end of an abandoned pecan orchard on the ranch. The orchard was fenced, preventing entry by livestock, but still accessible to whitetail deer and wild turkeys native to the ranch. Five currently available products used to control red imported fire ant colonies evaluated and compared are as follows:

1. Organic™ Solutions All Crop Multipurpose Commercial and Agricultural Insecticide (0.2% pyrethrins, 1.0% piperonyl butoxide or PBO and 82.9% silica dioxide) - 4 Tbsp (scoops)/gal water.
2. Bayer® Advanced Lawn® Fire Ant Killer (1.0% cyfluthrin) - 1 tsp or 2 tsp for mounds exceeding 12 inches diameter (only one in this trial), followed by drenching mound with 1 gal water. Note: 10 oz container treated about 65 mounds.
3. Ortho® Fire Ant Killer Granules II (0.2% bifenthrin) - 1 cup/mound, followed by drenching mound with 1 gal water. Note: 3.5 lb bag treated 9 mounds. "Prevents new mounds from forming for up to 4 months."
4. Terro® Fire Ant Killer (0.05% deltamethrin) - 1 Tbsp/mound applied as dry dust. Note: 24 oz. container treated 45 mounds.
5. Surrender® Brand Fire Ant Killer (75% acephate) - 2 tsp/mound applied as dry dust. Note: 16 oz container treated about 108 mounds.
6. Untreated control (wet) using 1 gal water drench per mound

7. Untreated control (dry) left dry.

In addition to the above treatments, soil samples were collected at pre-determined intervals from the Bayer®, Ortho® and Organic™ Solutions groups to determine pesticide residue levels over the period of the trial (see methods described below) - 30 days.

Twenty-eight plots of similar width, but varying in length, each containing ten imported fire ant mounds, were established on November 1, 2002. Plot numbers were arrayed from longest to shortest and divided into four blocks or replicates of seven plots each, with one replicate containing the longest plots, one containing the shortest plots and the remaining, intermediate blocks. Plot corners were marked with colored flags and mounds in that plot were marked with the corresponding color of flag. This method assured that re-invasion of ant colonies migrating from outside plots would be similar for all treatments. Treatments four and five were applied dry without a water drench and the remaining treatments were applied dry followed by an application of one gallon of clean water poured through a colander to simulate a sprinkling can.

At 2, 7, 14 and 30 days after treatment, ant mounds were disturbed slightly and evaluated for ant activity, if any. If a dozen or more worker ants emerged from the slightly disturbed mounds within 30 seconds, the colony was determined to be active. On days 7 and 30 following treatment, the number of "new" colonies appearing within the treatment plots was assessed to determine whether treated ant colonies had moved to new locations or split into more than one colony.

To collect soil samples for pesticide residue analysis, three plots of 20 mounds each were laid out separately from the treatment area and treated in the same manner with either the Bayer®, Ortho® or Organic™ Solutions product on the same day as the rest of the trial. An untreated plot of 20 mounds was also laid out. Prior to treatment and within 1 hour after treatment, soil samples of approximately 10 oz. (285 g.) were collected from each of the four plots described above, placed into a labeled soil sample bag and then placed into a cooler full of ice. In addition, samples were then collected from different mounds within the same plot in a similar manner on day 7, 14 and 30 after treatment. Soil samples were collected at an average depth of four to six inches (10 to 15 cm) from within the sampled mounds. Soil samples were stored in a darkened freezer at 0ºF (-17.8ºC) until the end of the trial. At the end of the trial, all soil samples were hand-delivered in an ice chest to Environmental Laboratory Services in Austin, Texas, for analysis. During the trial, the median daily temperature was 55ºF (12.8ºC), the site received 1.2 inches (3.0 cm.) of rain and the soil type at the site was a heavy clay loam vegetated with native bunch grasses and bermuda grasses.

Results

All treatments significantly reduced ant activity in treated mounds relative to mounds in the untreated check plots (**Table 1.**). At the 2 day mark after treatment, insecticides applied with a water drench were significantly more effective than those applied dry, but all treatments were equally effective by day 14 after treatment. It should be noted that all treatments applied dry did not result in complete elimination of active mounds at any time during the trial (maximum of 97% reduction), while all treatments applied with a water drench had 100% reduction in activity of treated mounds at the end of the trial. Water applications to the untreated mounds did not result in statistically significant differences in the number of active mounds compared to untreated fire ant mounds left dry, but the disturbance of the untreated mounds due to adding the water drench did result in slightly lower means than those untreated mounds left dry. On the Day 14 and Day

30 evaluations of "new" mound formation in all plots, new mounds were noted in the vicinity of inactive, untreated mounds, especially those that had been "watered."

Analysis of soil samples (**Table 2.**) revealed that cyfluthrin levels remained highest at the end of the trial while bifenthrin levels were lowest. Pyrethrin levels on average were lowest throughout the trial.

Discussion

Organic™ Solutions All Crop Multipurpose Commercial and Agricultural Insecticide (0.2% pyrethrins, 1.0% piperonyl butoxide or PBO and 82.9% silica dioxide (amorphous form harvested from freshwater diatoms)), contains plant-derived or botanical ingredients considered by some to be "organic." Piperonyl butoxide is extracted from the South American Ocotea (sassafras) tree, reacted with butylcarbityl and added as a synergist for pyrethrins. There are mixed opinions on the status of PBO as "organic" because of the chemical reaction involved in the extraction process. Regardless, Organic™ Solutions is formulated with botanical pyrethrins extracted from the powdered, dried flower head of the African-grown chrysanthemum, *Chrysanthemum cinerariaefolium*, in contrast to the synthetic active ingredients contained in other products evaluated in this trial. Bifenthrin, cyfluthrin and deltamethrin are pyrethroid insecticides which differ from pyrethrins because they are synthetically produced molecules that have relatively longer persistence when applied to the soil. Soil persistence documented through soil analysis bears this out except on Day 30, when sampling procedures used may have affected the amount of bifenthrin in the treated soil (**Table 2**). Acephate is an organophosphate insecticide which breaks down relatively quickly when in contact with organic material in soils.

Toxicological properties of treatments. Factors to be considered when selecting a product for treating imported fire ant mounds are discussed in fact sheet FAPFS036 posted on the web site, http://fireant.tamu.edu. Soil persistence can be a selection factor and in certain instances when products with less soil persistence are desirable. The mode of activity of natural pyrethrins and synthetic pyrethroids is similar (they destabilize nerve cell membranes and are relatively quick-killing). However, other toxicological properties and cost considerations may also be important.

As active ingredients, pyrethrins are relatively less toxic than pyrethroid insecticides (**Appendix 1**). Conversely, when formulated and directed for use, toxicity of applied material can be dramatically changed. Both the toxicity of applied material and the amount of material used in the treatment are additional variables affecting insecticide "load" that results in the environment. Because of these factors, making direct comparison between products when selecting the "least toxic" materials can be difficult.

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Table 1. Number of active red imported fire ant mounds/10 mounds treated or per plot following treatment with selected ant mound insecticide product treatment, Nov. 2002, Comal Co., TX.

	Active ant mounds/10 mounds/plot (4 replications) or total/plot*					
Treatment	Day 2	Day 7	Total	Day 14	Day 30	Total
Untreated control (dry)	9.75a	9.75a	10.50a	9.75a	9.75a	12.50a
Untreated control (wet)	8.25a	9.25a	9.25a	9.75a	8.50a	9.75a
Organic™ Solutions	0.25c	0.00c	0.75cd	0.00b	0.00b	2.00c
(pyrethrins, PBO + DE) - solution	(97.4%)	(100%)		(100%)	(100%)	
Bayer® Advanced Lawn®	0.00c	0.00c	0.75cd	0.00b	0.00b	2.00c
(cyfluthrin) - watered in	(100%)	(100%)		(100%)	(100%)	
Ortho® Granules 2	0.00c	0.00c	0.25d	0.00b	0.00b	3.00bc
(bifenthrin) - watered in	(100%)	(100%)		(100%)	(100%)	
Terro® Fire Ant Killer	3.00b	1.75b	2.50b	0.50b	0.25b	2.75bc
(deltamethrin) - dry	(69.2%)	(82.1%)		(94.9%)	(97.4%)	
Surrender® Brand	2.50b	0.25c	2.25bc	0.25b	0.25b	4.25b
(acephate) - dry	(74.4%)	(97.4%)		(97.4%)	(97.4%)	

* Means (average values) in columns followed by the same letter are not significantly different using analysis of variance (ANOVA) using Duncan's Multiple Range test at the 0.5 level of probability. Percent controls are in parenthesis under the mean values.

Table 2. Soil analysis conducted by Environmental Laboratory Services, Austin, TX, on soil samples from the Ingram Ranch, Nov. 2002, Comal Co., TX.

Insecticide	Day 0 Pre-Trt	Day 0 Post-Trt*	Day 2 Post-Trt	Day 7 Post-Trt	Day 30 Post Trt
pyrethrins[o]	ND[a]	170	140	140	100

bifenthrin	ND[a]	4000	1200	480	45
cyfluthrin	ND[a]	5800	2300	1700	1200

[a] ND - Not Detected at the Reporting Limit
* Values listed in ug/kg.
[o] Organic™ Solutions product contained 0.2% pyrethrins formulated with piperonyl butoxide and silica dioxide or diatomaceous earth, Ortho® product contained 0.2% bifenthrin, Bayer® product contained 1.0% cyfluthrin.

Appendix 1. Toxicological properties of Imported Fire Ant Insecticide active ingredients and formulated products (from Agricultural Chemicals, Book I, Insecticides. W.T. Thompson 2001, Product MSDS's).

Botanicals

pyrethrins - CAUTION; (rat) Oral LD_{50} : **1,500 mg/kg**
Organic™ Solutions Fire Ant Killer (rat) Oral LD_{50} : **>5,000 mg/kg**

Pyrethroids

bifenthrin - WARNING; Class II; (rat) Oral LD_{50} : **54.5 mg/kg**
Ortho® Fire Ant Killer Granules II (rat) Oral LD_{50} : **>5,000 mg/kg**

cyfluthrin - CAUTION; (rat) Oral LD_{50} : **500 mg/kg**
Bayer® Advanced Lawn® Fire Ant Killer (rat) Oral LD_{50} : **3084 mg/kg**

deltamethrin - WARNING; (rat) Oral LD_{50} : **128 mg/kg**
Terro® Fire Ant Killer Dust Oral LD_{50} : **>5,000 mg/kg**

Organophosphates

acephate - CAUTION; Class II; Tech (rat) Oral LD_{50} : **947 mg/kg**
Surrender® Brand Fire Ant Killer (rat) Oral LD_{50} : **1030 mg/kg**