Two Formulations of Granular Permethrin
for the Control of Individual Colonies of Red Imported Fire Ants

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With the recent regulatory actions regarding some active ingredients (chlorpyrifos, diazinon) available for use in individual mound treatments for red imported fire ants (*Solenopsis invicta* Buren), many other products are being tested as replacements. One of these is the synthetic pyrethroid, permethrin. Control Solutions, Inc. has recently received conditional labeling for use of granular permethrin at 0.25% active ingredient. This test was designed to provide efficacy data on permethrin formulated on two granular carriers, limestone and the cellulose-based BioDac®. Additionally, two rates of each of the formulations were tested.

Objective: Test the effectiveness of permethrin formulated on two different carriers for the control of individual colonies of fire ants.

Materials and methods

The test site was an ungrazed, mowed area located at Coulter Field, the Bryan, TX municipal airport. Fire ant density was about 400 active mounds per acre. A strip, 30 feet wide and indeterminate length was first established. To take advantage of high mound density two parallel strips were established. Beginning at one end of each strip all active fire ant mounds were marked with a single color surveyor's flag until the first 10 were marked. This set of 10 mounds was considered a plot. Flag color was changed for the next 10 mounds and so on until a sufficient number of plots were marked. Next, flags were placed along the edge of the strip between plots to define the length, and therefore area, of each plot. Plot lengths were arrayed from shortest to longest, then divided into four equal sets (replications).

Treatments were assigned within replications so that the total lengths (areas) of each treatment were as equal as possible. In this way, there was one replication of high-density plots, two of medium-density and one of low-density. Total area for all treatments was approximately the same to help equalize the chances of colony re-location/shattering within plots and re-invasion pressure from outside plots. (Barr and Best, 2002).

Treatments were applied on October 20, 2000 at the rates listed below, then irrigated with one gallon of water per mound. Weather during application was cloudy, with temperatures in the 70's. The ants were very active with brood visible near the tops of mounds.

Evaluations were conducted using the minimal disturbance technique in which mounds were lightly disturbed with a pointed tool handle and ant response observed. Mound activity (+ or -) was determined by the best judgement of the evaluator relative to activity of untreated mounds in the prevailing weather and soil conditions.

Post-treatment evaluations were conducted on October 21 (24 hours), 23 (3 days), 27 (7 days), November 5 (14 days) and November 17 (1 month). Plots were surveyed at 7 days and one month for the presence of new mounds. To better use valuable space, this test was combined with "Deltamethrin Dust for the Control of Individual Colonies of Red Imported Fire Ants" (p.68)

Appropriate data were extracted and analyzed separately using PC SAS analysis of variance procedures with means separated using Tukey's studentized range (HSD) test, $P < 0.05$.

Table 1. Included treatments. Coulter Field, Bryan, TX, 2000

Active Ingredient	Formulation/carrier	Application
water only (control)	-	1 gal/md
permethrin, 0.25%	BioDac®	1 cup/md, w/1 gal water
permethrin, 0.25%	BioDac	½ cup/md, w/1 gal water
permethrin, 0.25%	dispersable limestone	1 cup/md, w/1 gal water
permethrin, 0.25%	dispersable limestone	½ cup/md, w/1 gal water
diazinon, 5.0%	Spectracide® brand	½ cup/md, w/1 gal water

Results and Discussion

As shown in **Table 2**, after one day, treatments with the limestone formulations of permethrin and the diazinon standard resulted in significantly ($P<0.05$) fewer active mounds versus untreated plots and the BioDac treatments. Control for limestone and diazinon was 98% and 100% respectively. The BioDac formulations, though still significantly ($P<0.05$) reduced versus untreated plots, resulted in significantly ($P<0.05$) less control than the limestone and diazinon treatments.

Results remained fairly consistent numerically at the three-day evaluation, but the BioDac treatments showed an increase in control to the same statistically significant ($P<0.05$) level as the limestone and diazinon. By 7 days post-treatment, the BioDac treatments showed similar numerical control to the limestone and diazinon and all had significantly ($P<0.05$) fewer active mounds than the untreated control.

Counts of new mound formation at seven days, however, proved very interesting. Both BioDac formulations showed significantly ($P<0.05$) more "new" mounds per plot than the untreated control, ½ cup limestone and diazinon. This level of new mound formulation, coupled with relatively poor short-term control is a clear indication of colony relocation after treatment with BioDac-formulated permethrin. Total mound presence (treated mounds + new mounds) in plots at the 7-day count reflected this trend.

Between the 7 and 16-day evaluations, the entire region received over six inches of rainfall. The area around Coulter Field received 6 inches the first night of the rain event with an additional 4 inches in succeeding days. Consequently, the soil was saturated for the remainder of the test and many marked mounds were barely recognizable. Continued rains resulted in a substantial drop in untreated mound numbers, as well.

At 30-days post-treatment, there were no active mounds left in any of the treated plots, but only 50% of the untreated mounds remained active. New mounds showed the same trend as at seven days with BioDac-treated plots having numerically more active mounds than the others. In terms of total mounds, only the limestone formulations and diazinon resulted in statistically significant ($P<0.05$) reductions versus the untreated control. BioDac formulations were numerically lower, but plots still had roughly three times as many active mounds as the limestone

and diazinon treatments.

From a use standpoint, both permethrin products were easy to apply, though gloves were a necessity. The limestone produced considerable dust, so a face mask is highly recommended, as well. Another less-than-desirable aspect of BioDac was that, even after repeated, torrential rains, the material was still visible on the ground surface a month after application.

Performance of both the limestone and BioDac carriers were analyzed separately. These results are presented in **Table 3** and **Table 4**. There were no statistical differences in effectiveness between rates of the same carrier. The limestone formulation performed similarly to diazinon, while the BioDac formulation resulted in somewhat slower control in the early days of the test.

In summary, results indicate that permethrin formulated on limestone gives almost as good and rapid control as diazinon, the standard treatment. BioDac resulted in only fair and slow control with a strong indication of colony movement. The likely cause is the tendency of synthetic pyrethroids to bind to organic material. Since the conclusion of this test, the EPA has discontinued residential uses of diazinon (Dec. 2002) and will shortly do the same for chlorpyrifos (Dec. 2003). Given the right carrier, granular permethrin shows promise as an effective substitute for traditional individual fire ant mound treatments such as diazinon and chlorpyrifos.

Table 2. Results of mound evaluations: all treatments, 10 mounds per plot treated, 4 replications. Bryan, TX, treated October 20, 2000.

	Mean number of active mounds								
Treatment	1 day	3 day	7 day	7 day new	7 day tot	16 day	30 day	30 day new	30 day tot
untreated	9.25 a	9.25 a	8.25 a	2.25 b	10.50 a	7.25 a	5.00 a	4.25 a	9.25 a
BioDac, 1 cup	4.00 b	3.75 b	1.75 b	5.75 a	7.50 ab	0.25 b	0.00 b	6.25 a	6.25 ab
BioDac, ½ cup	4.25 b	3.25 b	0.50 b	6.00 a	6.50 bc	0.50 b	0.00 b	6.25 a	6.25 ab
limestone, 1 cup	0.75 c	0.50 b	1.50 b	3.75 ab	5.25 bcd	0.00 b	0.00 b	1.75 a	1.75 b
limestone, ½ cup	0.75 c	1.00 b	0.50 b	3.00 b	3.50 cd	0.00 b	0.00 b	1.25 a	1.25 b
diazinon	0.00 c	0.50 b	0.25 b	2.50 b	2.75 d	0.00 b	0.00 b	0.75 a	0.75 b
F	21.42	13.44	17.00	8.23	9.90	77.03	31.62	2.27	5.01
P	0.0001	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001	0.0818	0.0036
R^2	0.9195	0.8776	0.9006	0.8144	0.8407	0.9762	0.9440	0.5473	0.7279
MSD	2.7823	3.3270	2.7264	2.6389	3.7281	1.2108	1.3264	6.1550	5.7101

Means in the same column with the same letter are not significantly different. Means separated by Tukey's

studentized range (HSD) test, $P < 0.05$. df = 15.

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Table 3. Results of mound evaluations: permethrin on limestone carrier only, 10 mounds per plot treated, 4 replications. Bryan, TX, treated October 20, 2000.

	Mean number of active mounds								
Treatment	1 day	3 day	7 day	7 day new	7 day tot	16 day	30 day	30 day new	30 day tot
untreated	9.25 a	9.25 a	8.25 a	2.25 a	10.50 a	7.25 a	5.00 a	4.25 a	9.25 a
limestone, 1 cup	0.75 b	0.50 b	1.50 b	3.75 a	5.25 b	0.00 b	0.00 b	1.75 a	1.75 b
limestone, ½ cup	0.75 b	1.00 b	0.50 b	3.00 a	3.50 b	0.00 b	0.00 b	1.25 a	1.25 b
diazinon	0.00 b	0.50 b	0.25 b	2.50 a	2.75 b	0.00 b	0.00 b	0.75 a	0.75 b
F	41.15	134.56	26.27	3.37	10.98	66.89	25.50	1.26	8.35
P	0.0001	0.0001	0.0001	0.0503	0.0011	0.0001	0.0001	0.3607	0.0029
R^2	0.9648	0.9890	0.9460	0.6918	0.8798	0.9781	0.9444	0.4573	0.8476
MSD	2.1531	1.1779	2.3558	2.5754	3.6791	1.3888	1.5609	4.9085	4.3841

Means in the same column with the same letter are not significantly different. Means separated by Tukey's studentized range (HSD) test, $P < 0.05$. df = 9.

Table 4. Results of mound evaluations: permethrin on BioDac carrier only, 10 mounds per plot treated, 4 replications. Bryan, TX, treated October 20, 2000.

	Mean number of active mounds								
Treatment	1 day	3 day	7 day	7 day new	7 day tot	16 day	30 day	30 day new	30 day tot
untreated	9.25 a	9.25 a	8.25 a	2.25 b	10.50 a	7.25 a	5.00 a	4.25 a	9.25 a
BioDac, 1 cup	4.00 b	3.75 b	1.75 b	5.75 a	7.50 ab	0.25 b	0.00 b	6.25 a	6.25 ab
BioDac, ½ cup	4.25 b	3.25 b	0.50 b	6.00 a	6.50 bc	0.50 b	0.00 b	6.25 a	6.25 ab
diazinon	0.00 c	0.50 b	0.25 b	2.50 b	2.75 c	0.00 b	0.00 b	0.75 a	0.75 b
F	16.38	9.89	16.00	11.38	9.12	75.50	25.50	1.84	4.09
P	0.0002	0.0016	0.0002	0.0009	0.0021	0.0001	0.0001	0.1966	0.0294
R^2	0.9216	0.8682	0.9143	0.8836	0.8587	0.9805	0.9444	0.5513	0.7315

MSD	2.9662	3.6467	2.9490	2.2976	3.7564	1.2745	1.5609	6.5711	5.8288

Means in the same column with the same letter are not significantly different. Means separated by Tukey's studentized range (HSD) test, $P < 0.05$. df = 9.