Broadcast and Skip Swath Bait Treatment Effects
on Fire Ant Mound Height and Density
Victoria County, Texas - 2008-2009

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Red imported fire ants (*Solenopsis invicta* Buren) cause numerous problems in cattle and hay production systems. Problems such as electrical failures and stinging incidents are directly related to the presence of the ants themselves. However, particularly in hay pastures, the ants' mounds cause most of the problems. Large mounds jam cutters and balers, dull blades and can result in substantially lower equipment speed and increased wear and tear due to the roughness of the ground. Mounds are a particular problem in heavy clay soils where they are overgrown by grass and become an almost permanent part of the landscape.

There are two potentially cost-effective methods for resolving these problems - baits and dragging. Broadcast baits can reduce fire ant populations by over 90% in a single application at a cost of roughly $12 per acre (product cost only). Baits will solve most of the ant-related problems, but do little to solve the problems caused by mound structures. Mechanical dragging, on the other hand, effectively eliminates the mound-caused problems, but does little to kill the ants, which will immediately begin to rebuild their mounds. This trial was designed to test the effectiveness of both methods singly and in combination using two different broadcast baits - Esteem and Extinguish Plus.

Materials and Methods

The trial was located on the property of Dr. Ray Smith in Victoria County, Texas in the Texas Coastal Plain. The site is in the flood plain of the Colorado River and has heavy, black clay soil. Standing water is common after heavy rains and, in response, the ants have built very large mounds. The site was grazed, and had a good cover of well-managed native grasses.

One purpose of the trial was to replicate real-life management practices using the cooperator's equipment under his operation. Consequently, test plots were large (an average of about 5 acres) and could not be replicated. Treatments included: Esteem (0.5% pyriproxyfen) and Extinguish Plus (0.36% hydramethylnon, 0.25% s-methoprene) and an untreated control. Both baits were applied at a rate of 1.5 lbs./acre using a Herd GT-77 seeder. Each treatment was applied to two plots. One plot was full coverage, the other was a skip swath application on approximately 50 foot centers, resulting in 0.75 lbs/acre total application weight.

Finally, half of each of the five plots was dragged. Because of the size and permanence of the mounds, dragging was not an easy task. After several attempts, the owner finally resorted to using the front-loader bucket of his tractor to knock down the mounds followed by dragging with a pin harrow to get them flush with ground level.

Pre-counts were conducted on May 14, 2008. High winds that would have made the skip swath applications very inaccurate prevented bait application until May 31. Evaluations were then conducted on July 3, 2008, January 8, 2009 and June 5, 2009.

Because of the need to mechanically drag half of each plot and ongoing grazing pressure, it would have been very difficult to accurately establish permanent marks. It was therefore decided to sample using random transects. Each transect was 150 ft. long and 30 feet wide, giving a sample area of 0.103 acres. Transects ran perpendicular to the bait application swaths so as to

encounter as many "skips" as possible in those two plots. For each transect, the approximate diameter and height of each mound was measured with a ruler or tape measure and recorded, along with whether the mound was occupied by ants.

Results and Discussion

The mounds in this trial were truly enormous, but not atypical of mounds found in heavy clay soils. The *average* mound at pre-count was over 25 inches in diameter and over 10 inches tall. Dozens of mounds were 36 inches in diameter and some were over 48 inches. Many were over 14 inches tall with some as tall as 18 inches. The mounds made the pastures unsightly, to say the least, and they were actually dangerous to drive any vehicle over at more than five or six miles per hour. Because of the large size and low density, it was assumed that the majority of colonies were monogyne (single queen).

The region had been plagued by low rainfall for some months at the time of applications and conditions only worsened. By spring 2009, the area was rated as in "exceptional" drought, the worst rating. The drought undoubtedly affected the ants. Many of the mounds rated as "live" did, indeed, have a colony living in the mound structure, but the ants actually occupied only a small fraction of the mound. For instance, a mound 36 inches in diameter might have a pocket of worked soil only 6 inches in diameter during the January evaluation. At the July evaluation, there was no freshly worked soil whatsoever, so alive-dead ratings were highly suspect.

The drought only worsened into 2009, reaching historic proportions. With luck and a close eye on the weather radar, the June 5 evaluation was conducted two days after an isolated thunderstorm moved over the test site. Mound building was good and the vegetation grazed very short making for excellent visibility. Mounds of only a few inches in height and diameter were easily spotted.

Because the treatments were not truly replicated, it was inappropriate to analyze them using statistical methods such as analysis of variance. Fortunately, many of the differences were well illustrated by simple summary statistics. One challenge of the analysis was finding a way to express the number, condition (alive or dead) and size (height and diameter) of the mounds with a simple expression that could be easily compared between treatments. Mound counts or densities did not express mound size. Average heights did not take density into account; i.e. 10 mounds could have the same average height as 100 mounds.

It was finally decided that it was best to separate bait effectiveness and dragging. Bait effectiveness was expressed simply by the total number of live mounds in both dragged and undragged sub-plots of each treatment, as shown in **Table 1.** Because the plots were not replicated, there was no way to equalize any pre-count factor so substantial differences existed between plots at test initiation.

Comparison of dragging effectiveness was more complicated. The mound structure itself causes the most damage so it was not necessary to differentiate between occupied (live) or abandoned mounds for this comparison. Mound height is the most important factor in equipment damage, but diameter also plays a role. For example, a mound 12 inches high and 36 inches in diameter is a much more potentially damaging structure than a mound of the same 12-inch height but only 18 inches in diameter.

Therefore, it was decided that mound volume might be the most accurate and useful comparison. Volume was calculated using the formula for the volume of a partially filled sphere:

$$\Pi h^2 (r\text{-}h/3).$$

The major assumption was that mounds are spherical which, of course, they are not, but it was the best fit of any regular geometric shape. As mentioned, averages did not take mound number into account, so the volumes of all mounds were simply summed. **Table 2** shows the results of dragging the different treatments.

It was expected that Extinguish Plus, because of its faster-acting hydramethylnon component, would eliminate colonies considerably faster than the IGR-only Esteem. However, as shown in **Table 1**, there were few differences in effectiveness between the two baits at both Week 5 (July) and Week 33 (January). The drought was the likely reason because it both caused the Esteem-treated ants to die faster than usual and resulted in so little freshly worked soil that existing mounds were very difficult to find. By January, a total of only seven active mounds were found in all four bait-treated plots.

Table 1. Total number of mounds per three 150 x 30 ft. transects. (Total area = 0.31 acres)

	Pre-count		Week 5		Week 33		Week 52	
Treatment	Live	Tot	Live	Tot	Live	Tot	Live	Tot
Untreated - undragged	15	29	9	15	14	23	16	29
- dragged	14		6		9		13	
Ext. Plus, full coverage - undragged	19	34	4	5	1	1	2	11
- dragged	15		1		0		9	
Esteem, full coverage - undragged	7	14	5	7	3	3	21	35
- dragged	7		2		0		14	
Ext. Plus Skip Swath - undragged	12	29	9	12	1	1	7	27
- dragged	17		3		0		20	
Esteem Skip Swath - undragged	6	23	6	10	2	2	17	37
- dragged	17		4		0		20	

At Week 5, there were roughly double the number of active mounds in the skip-swath plots than in their full-coverage counterparts. It is unknown whether these differences were statistically significant or the result of not being able to fully replicate treatments. After disappearing in the January evaluation, the differences reappeared at one year, but only in the Extinguish Plus plots. The number of active mounds were similar between the Esteem full coverage and skip-swath plots. Extinguish Plus was the only treatment to show substantially fewer active mounds at one year post-treatment.

The results of dragging (**Table 2**) showed the expected dramatic differences. In the dragged halves of the plots, there were almost no mounds to be seen. There were large areas of bare soil where the mounds had once been, but nothing tall enough to damage equipment. Most former mounds, in fact, were depressed an inch or two because of their collapsed underground galleries. By January, despite the drought, vegetation had begun to overgrow many of these bare patches.

Mounds in the dragged half of the untreated plot had begun to rebuild by January while there was no rebuilding in any of the treated plots. By one year post-treatment, the differences were stark. None of the treated, dragged plots had more than 0.5 ft^3 of soil displaced while the ants had moved 5.47 ft^3 of soil in the untreated, dragged plot. This was an obvious indicator of the effectiveness of bait treatments on mound formation. There was also considerably more

displaced soil in the skip-swath plots versus full coverage, though these differences were probably due to the larger pre-count volume.

It is interesting to note the actual volume of soil displaced by fire ant activity. The average for all plots at pre-count was 2.35 yd^3 with a range of 1.29 yd^3 to 4.18 yd^3. Two or three cubic yards of soil spread across one-third of an acre is not very much, a layer a millimeter or two thick. However, that displaced soil comes from underground tunnels dug by the ants. These tunnels provide paths for increased aeration and water infiltration which may be quite beneficial, especially in heavy clay soils. The excavated soil may also have better structure and move nutrients to the soil surface. This observation only adds to the importance of analyzing the costs and benefits of fire ant treatments.

Table 2. Total mound volume per plot, in **cubic feet** ($ft.^3$) using formula: Πh^2 (r-h/3)/1728. Three 150 x 30 ft. transects per plot. (Total area = 0.31 acres)

	Pre-count		Week 5		Week 33		Week 52	
Treatment	Drag	Undrg	Drag	Undrg	Drag	Undrg	Drag	Undrg
Untreated	62.0	98.6	0.4	45.6	3.8	34.4	7.1	35.2
Exting. Plus, full coverage	40.7	42.4	0.1	63.8	0.0	40.2	0.28	19.6
Esteem, full coverage	38.4	34.9	0.1	41.4	0.0	16.5	0.46	21.6
Exting. Plus Skip Swath	61.4	60.4	0.1	60.6	0.0	26.4	0.35	30.2
Esteem Skip Swath	83.1	112.9	0.1	65.4	0.0	67.0	0.40	40.1

Tables 3 and **Table 4** list the average mound diameter and height in the plots, dragged versus undragged. The alive and dead mound data were summed. At week 33, there were simply no mounds, alive or dead, in the treated plots. Not surprisingly, the dragged half-plots had substantially lower mound heights than the undragged half. Even after dragging, however, mounds rebuilt to some extent in the untreated plot. This observation alone might justify treatment in areas where mound height (or visibility) is important, such as hay fields and ornamental turf.

At one year post-treatment, there were still substantial differences between the dragged and undragged half-plots, particularly in average mound diameter. It was very evident that mounds in the treated, dragged plots were the result of re-invasion. The same was only partially true in undragged half-plots as some colonies had re-inhabited existing mound structures. Mound heights declined in undragged plots due to weathering and trampling.

Table 3. Mean mound diameter (in.). Three 150 x 30 ft. transects per plot. (Total area = 0.31 ac.)

	Pre-count		Week 5		Week 33		Week 52	
Treatment	Drag	Undrg	Drag	Undrg	Drag	Undrg	Drag	Undrg
Untreated	24.7	28.5	12.0	24.6	18.6	25.0	16.5	25.5
Exting. Plus, full coverage	19.6	24.7	-	28.1	-	27.7	6.2	24.8
Esteem, full coverage	26.9	29.1	-	28.2	-	28.3	7.4	17.8
Exting. Plus Skip Swath	26.1	25.6	6.0	29.6	-	34.0	8.3	24.4
Esteem Skip Swath	23.3	32.3	6.5	30.4	-	31.8	6.4	22.3

Table 4. Mean mound height (in.). Three 150 x 30 ft. transects per plot. (Total area = 0.31 ac.)

	Pre-count		Week 5		Week 33		Week 52	
Treatment	Drag	Undrg	Drag	Undrg	Drag	Undrg	Drag	Undrg
Untreated	10.4	12.5	2.5	9.5	6.4	8.3	5.6	8.2
Exting. Plus, full coverage	7.7	9.9	3*	10.6	-	7.4	2.4	7.5
Esteem, full coverage	9.5	10.0	2*	9.9	-	6.8	2.4	5.0
Exting. Plus Skip Swath	10.2	11.1	2	10.4	-	9.1	2.4	7.6
Esteem Skip Swath	10.9	10.8	2	11.0	-	7.3	1.8	6.1

* Only one mound was found.

The overall goal of this trial was to evaluate the effectiveness of both bait treatment, dragging and the combination of the two on mound characteristics. Bait treatments, regardless of type or application method, reduced mound numbers very effectively. A bait treatment alone might be sufficient on land where the presence of ants is the critical factor, such as turf harvesting and recreational use.

Dragging unquestionably took care of mound height issues and might prove valuable for land uses such as hay harvesting, vehicular movement and ornamental turf. (Without human traffic, as long as turf looks good, it doesn't matter whether ants are present or not.)

The real question is whether the combination of the two is useful. Dragging has little effect on bait unless it disrupts collection by dragging too soon before or after bait application. However, the data show that a bait application can *substantially* reduce mound-related problems in the long term. At one year, despite the recovery of colony numbers to pre-count levels (Table 1), displaced soil volume was still 50 to 100 *times* less in treated, dragged plots versus undragged. In untreated plots, the difference was only a factor of five (Table 2). Mound diameter in treated plots was half to one-fourth the diameter in undragged plots (Table 3) and heights were less than half (Table 4). In untreated plots, diameter and height were only about 30% less.

Critically for hay production, the average mound height at one year post-treatment in treated, dragged plots was 2.25 inches while in untreated plots it was 5.6 inches. Most hay is cut at a height of three or four inches. Therefore, mounds in dragged, treated plots were still low enough to not interfere with most haying activities. Mounds in undragged plots were still high enough to cause problems.

In summary, fire ant treatment option depends on land use. If the ants themselves are the problem, then semi-annual application of a broadcast bait is the better choice. If the mounds are the problem, dragging is the better choice and its effectiveness and duration is greatly enhanced by bait application.

Finally, we would like to extend our deepest thanks to Dr. Smith for allowing us to use his property and for the *considerable* time and effort he spent in applying the baits and, particularly, flattening the hundreds of huge mounds in the dragged halves of the plots.