EVALUATION OF ACROLEIN AS AN INDIVIDUAL RED IMPORTED FIRE ANT MOUND TREATMENT

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Acrolein (92%, a three carbon aldehyde that breaks down sulfuryl molecules) is currently marketed as Magnacide® H Herbicide by Baker Performance Chemicals, Incorporated (3920 Essex Lane, Houston, Texas 77027). It is a highly toxic (signal word DANGER), Restricted Use, liquid under pressure used in the control of submersed and floating weeds and algae in irrigation canals. Acrolein is also marketed as a rodenticide. The product cost is estimated at $0.15 per 20 mls. It is highly volatile and water soluble and upon release, produces a toxic fumigating vapor.

With the impending loss of methyl bromide (currently registered for control of red imported fire ants and the Texas leaf cutting ant) in the year 2000, Baker Performance Chemicals, Inc. is investigating the possibility of acrolein as a replacement. Soil injected pesticides are exempt from food tolerances that pertain to pesticides applied above ground.

Materials and Methods

Acrolein was applied under the supervision of and using tractor mounted special equipment supplied by the manufacturer. Acrolein was propelled using nitrogen gas and the dose was metered using a timer activated by a trigger on the injector rod. The acrolein injector rod had lateral openings on the injector tip and all treatments were applied inside of the mound below the soil line.

<u>Trial 1</u>. Rate response. Six treatments were evaluated to reduce the number of red imported fire ant mounds in treated areas. Treatments included:

1) untreated control
2) 16 mls. applied with a single insertion into a mound
3) 32 mls. applied with a double insertion into a mound
4) 48 mls. applied with a triple insertion into a mound
5) 25 mls. applied with a single insertion into a mound
6) 75 mls. applied with a triple insertion into a mound

Three replicated plots of equal width and variable length, containing ten (10) red imported fire ant mounds with diameters for 8 or more inches were established for each treatment (30 mounds treated per treatment). Treatment were assigned to the three blocks in the order listed above. Each mound was marked with a plot flag and received one of the six treatments. Prior to treatment, mounds were selected by size and ant activity. Time required to treat each plot was recorded.

Time required to treat each 10 mound set within a plot are listed below. Nozzle problems occurred in block 2 (second replicate) which caused some time delay. Each block was treated by a different individual. Treatments were applied between 9:54 am and 1:20 pm. Temperature ranged from 66 to 67.9○F, and relative humidity was 38 to 36.9 percent. Soil temperature was not recorded. Plots had been mowed 23 March, 5 days prior to plot establishment and treatment.

Treatment	Treatment time
1) untreated control	---
2) 16 mls. applied with a single insertion into a mound	1:30, 2:10, 1:20
3) 32 mls. applied with a double insertion into a mound	1:48, 3:20, 2:49
4) 48 mls. applied with a triple insertion into a mound	2:24, 6:05, 4:40
5) 25 mls. applied with a single insertion into a mound	1:35, 2:06, 2:36
6) 75 mls. applied with a triple insertion into a mound	3:45; 4:30, 4:47

Periodically (0, 2 and 10 days; on 28, 30 March and 7 April), mound activity was monitored. Following treatment, ant activity in monitored mounds was rated on a 0 to 5 scale, with 0 being "no activity" and 5 being highly active mounds. In addition, mounds in one set (replicate) of plots were opened using a shovel and presence of brood was noted. The presence of "satellite" mounds, defined as small freshly-produced ant mounds within a foot of the treated mound, were noted.

Trial 2. Based on the results of the rate test in the spring of 1995, two additional trials of acrolein were conducted to determine efficacy versus standard chemicals. The first site was a roadside in Burleson County, Texas near the Brazos River. Soil was a friable, deep, silty bottomland soil that, at the time of testing, was moist. A strip, 30 feet wide and indeterminate length was mowed with the grass clippings blown off the mowed area to aid mound location. Groups of 10 active mounds were marked using wire surveyor's flags. The length of each plot was then measured, the lengths arrayed from highest to lowest and blocked into groups of four. Treatments were then assigned randomly within each block. Treatments were as follows: 1) Untreated control; 2) Acrolein, 4 injections of 16 ml each; 3) acephate 75 percent dust (Orthene Turf, Tree and Ornamental Spray), 2 tsp. per mound; and 4) injectable chlorpyrifos (Whitmire PT270), multiple injections based on mound diameter.

Trial 3. The second site was located at the TAMU Riverside Campus approximately 200 yards from the Brazos River. Soil conditions were similar except the soil appeared to contain a greater percentage of clay than the other site. Site preparation and test layout were similar. Treatments were as follows: 1) Untreated control; 2) Acrolein, 4 injections of 16 ml each; and 3) Acrolein, 1 injection of 64 ml.

Treatments were made on 5 October 1995 before noon. Weather was clear, with a strong breeze, temperature between 75 and 80 degrees Fahrenheit. The acrolein was applied by Dave Blodgett of Baker Performance Chemicals using specialized application equipment. Acrolein-treated mounds were stepped on after application to help seal in the material. Other chemicals were applied according to label directions. Any additional mounds that were spotted during the treatment process were flagged and treated, but not included in post-treatment evaluations.

Evaluations were conducted before and periodically after treatment by lightly disturbing the mound and surrounding area and observing any ant activity. A mound was considered active if 20 or more ants rose to the surface within 30 seconds of disturbance (time varied depending on temperature and sun exposure). Acrolein was observed to cause satellite mounding in the previous test. As a result, a mound was considered active if there was any mound building activity around the immediate perimeter of the original mound as well as the mound site itself.

Results and Discussion

<u>Trial 1</u>. After 48 hrs. of treatment, during which time heavy rains had occurred, the effects of treatments appeared to be dose related (**Table 1**). From the 48 hour post-treatment evaluation, treatments 5 and 6 provided 67 to 90 percent elimination of ant activity in treated mounds. Optimum treatment for minimum 8 inch diameter mounds appears to lie in between these treatments. It was observed that increasing number of mound insertions enhanced distribution and performance of the fumigant within the mound. Therefore, four insertions of 16 mls. dose (64 mls. acrolein @ $0.48/mound) appears to be a likely candidate for an optimum dose.

The 8 day post-treatment evaluation (7 April 1995) produced results similar to the 48 hour evaluation (**Table 1**). The grass on and around mounds that received the high treatment rate of acrolein was chlorotic and necrotic. Ant activity began to resume in treated soil, indicating that any residual effects of the treatment had dissipated. Mounds in block 1 that had been rated using the Mound Indexing Method 2 days after treatment were found to be largely inactive. It is likely that heavy rains that occurred between these two ratings filled the loosened soil and caused surviving ants in these mounds to move away.

<u>Trial 2</u>. This trail compared acrolein to two chemicals and an untreated control. Acephate was included as a standard since it is considered the cheapest ($0.13 - $0.30 per mound), most easily used, and one of the most effective individual mound treatments available. The drawbacks to acephate dust include a very bad smell and its toxicity. It was hoped that acrolein would compare favorably with acephate's cost per mound and effectiveness. The second "standard" treatment was PT270 injectable chlorpyrifos, chosen because of the similar application method and target market, pest control operators (PCO's). The drawbacks of this product are high cost, at least $1.00 per mound, and the long residual activity of chlorpyrifos.

All treatments significantly reduced the number of active red imported fire ant mounds within 24 hours after treatment and throughout the 4 week monitoring period (**Table 2**). However, acrolein injections, using four injections of 16 mls. each, did not provide as great a reduction in active mound numbers as did the acephate or chlorpyrifos standard treatments. New mounds occurring within treatment plots 4 weeks after treatment were not significantly different between treatments. Results indicate that acrolein provides significant control ($P < 0.05$) of fire ant mounds versus an untreated mounds over the one month duration of the test. Acrolein provided an average control level of around 50%. However, it is significantly less effective than both acephate and chlorpyrifos, >95% control for both products.

Trial 3. This trial was conducted to support the results of Trial 1, but with equipment that worked properly and in much warmer, sunnier weather. It was noted during Trial 2 that four insertions of the applicator wand seemed to take a long time - long enough to be undesirable to a PCO employee. Therefore, the same amount of acrolein was injected using four sites versus one site in an effort to reduce application time. Unlike results of Trial 2, however, the acrolein ant mound treatment using four injections of 16 mls. each did not significantly reduce numbers of active ant mounds except 1 week after treatment as compared to untreated control plot data (**Table 2**). The single injection of 64 mls. performed better. A possible explanation is that, in weather that was sunny, windy and about 20 degrees warmer, the single, large injection of acrolein evaporated and/or dissipated more slowly than multiple injections exposing more ants for a longer time.

As mentioned, acrolein was noted to form new, "satellite" mounds along the edges of treated mound sites. This phenomenon was noted so frequently in both Trials 2 and 3 that if a satellite mound overlapped the original mound site, the mound was considered active. While satellite mound formation is one concern, mound "shattering" is another. Shattering occurs when treatment causes an ant colony to not only move, but split into more than one smaller colony. After the one month mound evaluation, the treatment plots were surveyed for additional mounds. Neither test showed a significantly higher number of new mounds between any treatments or the control. Therefore, it appears that while acrolein can cause surviving members of a colony to relocate, it does not cause shattering.

The application of acrolein was considerably improved over that of the Trial 1 with the modification of the injector wand. We experienced no irritation and virtually no odor from the acrolein during treatments. However, it was a near certainty that some gas would be released during set-up and, particularly, take-down of the injector apparatus. Though not a major concern if adequate safety precautions are taken, it could still be unpleasant and, possibly, unsafe.

In Trials 2 & 3, there was no rain from three days before the treatment date until the final evaluation, when approximately 1.25 inches fell the night before. Consequently, soil conditions were dry for the one and two week evaluations. Also, temperatures ranged from the 40's to the lower 90's over the course of the test. These factors help explain why the number of active mounds in a few plots appear to fluctuate. Ant activity varies greatly with the weather and even the time of day. Mounds that are "borderline" in their activity may appear "active" when conditions are favorable for the ants to be near the top of the mound, but "inactive" when the weather is hot, dry, and/or sunny, keeping the ants deeper in the mound regardless of the amount of disturbance. Several acrolein-treated mounds fit this description. Therefore, treatments should be compared only on the same evaluation date, not across time.

Conclusions

1) Acrolein's effectiveness is, at best, about 70%, averaging about 50%. This is generally considered unacceptably low, particularly by the PCO industry when "call-backs" by clients are expensive to the operator.

2) Acrolein is highly toxic with a very real potential for worker injury. The product's toxicity and potential danger to the public would exclude its use from urban and suburban areas - the primary market for PCO's.

3) Acrolein's cost, though low to moderate on a per-mound basis, is still greater than that of an acephate dust treatment and it is not as effective. Since the product's toxicity limits its use to non-urban areas, it must then compete with bait products for use on large areas. Baits cost roughly $10-12 per acre including labor and provide greater than 90% control, regardless of the number of mounds.

4) Acrolein is a herbicide. Consequently, it kills any vegetation around a treatment site. This is aesthetically unacceptable in an ornamental turf situation and could potentially cause costly damage if it were used around shrubs, trees, or other ornamental plants.

5) The equipment used to apply acrolein is rather elaborate and expensive, requiring a vehicle of some type to transport and use. Acephate dust application requires a teaspoon and a pair of gloves. The injectable chlorpyrifos was easily carried by one person and most other individual mound treatments require only a bucket and a water source.

While acrolein appears to have found a superior niche in rodent control and as an aquatic herbicide, there are fire ant control products on the market that are more effective, cheaper, safer, and easier to use.

Table 1. Activity of acrolein injections on red imported fire ant mounds, Burleson Co., Texas 28 March 1995.

Treatment and rate (mls.)		Cost	No. inactive mounds/30	Avg. rating	No. satellites
			---------------------- 48-hr. post treatment----------------------		
1	0	$0.00	0	4.10	0
2	16	$0.12	11	1.73	5
3	25	$0.19	11	1.69	8
4	32 (16x2)	$0.24	15	0.94	13
5	48 (16x3)	$0.36	20	0.90	8
6	75 (25x3)	$0.57	27	0.13	6
			---------------------- 8 days post treatment----------------------		
1	0	$0.00	0	4.00	2
2	16	$0.12	15	1.16	6
3	25	$0.19	20	0.83	9
4	32 (16x2)	$0.24	21	0.60	5
5	48 (16x3)	$0.36	19	0.93	6
6	75 (25x3)	$0.57	29	0.03	4

Table 2. Number of active red imported fire ant mounds before and after treatment with acrolein and standard insecticides., Burleson County, Texas, 1995.

Trial 1 Mean number of active fire ant mounds of 10*

					----------------4 wks------------------		
Treatment	24 hrs	3 days	1 wk	2 wks	Mounds	"Saltellites"	Total
untreated control	10.0a	10.0a	9.5a	10.0a	8.75a	4.0a	12.75a
acrolein	4.8b	6.0b	4.0b	5.5b	3.25b	5.0a	8.25b
acephate	2.3c	0.0c	0.0c	0.0c	0.00c	2.8a	2.75c
chlorpyrifos	0.3c	0.3c	0.3c	0.5c	0.00c	4.0a	4.00c
F value	37.99	204.3	124.0	77.37	61.50	0.90	11.61
Prob.	<0.01	<0.01	<0.01	<0.01	0.0001	0.5332	0.0009
MSE	0.951	0.229	0.333	0.528	0.5556	3.6736	3.6736
MSD	2.153	1.057	1.275	1.604	1.6453	4.231	4.231
df = 9							
crit. value = 4.415							

Trial 2

					----------------4 wks------------------		
Treatment	24 hrs	3 days	1 wk	2 wks	Mounds	"Satellites"	Total
untreated check	10.0a	10.0a	8.8a	8.5a	8.75a	3.00a	11.75a
acrolein							
4 x 16 mls.	8.5ab	7.0a	4.3b	3.5ab	6.25ab	2.25a	8.50a
1 X 64 mls.	6.0b	2.8b	1.3c	3.5b	4.00b	4.00a	8.00a
F value	2.89	8.03	16.00	7.54	7.13	2.36	3.15
Prob.	0.115	0.012	0.002	0.014	0.0166	0.1625	0.0977
MSE	2.333	2.750	1.444	1.778	4.3390	3.0833	5.4722
MSD	3.314	3.598	2.607	2.893	2.5311	3.8095	5.0751
df = 6							
crit. value = 4.339							

* Means followed in columns by the same letters are not significantly different using analysis of variance (ANOVA) and Tukey's Studentized Range Test ($P \leq 0.05$).