Evaluation of Hot Water Injections for the Control of Individual Red Imported Fire Ant Colonies Brazos Co., Texas - 1997

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This test was undertaken to determine the effectiveness of commercially-applied hot water injections for the control of red imported fire ant colonies. Funding was provided by the Fire Ant Control Company of Waco, Texas, who also supplied the equipment and experienced personnel to make the injections. Recently, a number of devices have been developed to inject either steam or hot water into fire ant mounds. These devices are currently being sold, rented and leased for such purposes and are being used by some pest control operators to eliminate fire ant mounds, control weeds, and for various other tasks.

The advantage hot water has over other forms of fire ant control is its rapid ant kill and the fact that only tap water is used in the injections, thus making the method appear to be more “environmentally friendly” than other methods that utilize chemicals. Conversely, some “organic” authorities do not consider very hot water to be an organic treatment because it sterilizes the soil and kills beneficial microorganisms. Since there is no residual activity from hot water treatments, all ants and queens must be killed immediately to effectively eliminate the colony from an area. Worker ants that are not killed outright die or move within a few days or weeks, but surviving queens will likely continue the colony.

Elimination of Ant Activity in Individual Mounds

Materials and Methods

The test was located in western Brazos County, Texas in an ungrazed pasture. The pasture had fire ant infestations in the 200-300 mounds per acre range and were considered to be the multiple queen form of ant colonies. Plots were established by marking several 30-foot wide strips 20 feet apart and of indeterminate length. Within each strip, beginning at one end, 10 active fire ant mounds were marked with wire surveyor’s flags of a single color. The next set of 10 mounds was then marked with another color and so on, alternating colors, until sufficient plots of 10 mounds each had been marked in the rows. Flags were placed along one edge of the plots at the midpoint between sets of mound-marking flags, thereby delineating the boundaries of each plot.

Plot lengths were measured and recorded. Lengths were then arrayed from highest to lowest and divided into 4 sets (replications) of 5 plots each. Within each replication, treatments were assigned randomly to plots. The total lengths of the 4 plots of each treatment were then summed. Treatments were then re-assigned within replications as needed so that the total plot length of all treatments were as equal as possible. In this way, bias was reduced in plot assignment and the area available for ant re-invasion was roughly equal for all treatments.

Treatments were made on the morning of 1 October 1997. Skies were clear and the temperature reached a high in the upper 80's that afternoon. Soil was moist and ant activity was distributed at all levels of randomly examined mounds. Treatments included:

Treatment	Material/method
hot water	Hot water injection apparatus, amount varied by mound
Sevin XLR® (41.2% carbaryl)	1.5 qt/100 gallons, 1 gallon/mound drench
untreated	Untreated
water drench	1 gallon water only drench/mound
water injection	4 gallons water only injection/mound

Three sets of control plots were included to help determine if it was the heat or the injected water that most disrupted colony activity. Evaluations were made at 1, 5, 8, 15, and 30 days post-treatment. Evaluations were conducted by lightly disturbing the treated mound structures with a pointed tool handle. A mound was considered active if a number of ants rose to the surface in a defensive manner within 15 seconds of disturbance. All plots were surveyed at the end of the test for satellite mound formation. Results were analyzed using PC SAS ANOVA procedures and Tukey's studentized range test for mean separations (P<0.05).

Statistical Analysis

Mean no. active mounds

Treatment	1-day	5-day	8-day	15-day	30-day	30 sat	30 tot
untreated	9.50 a	9.25 a	9.75 a	8.50 ab	8.50 a	1.25 a	9.75 a
hot Water	8.25 ab	5.00 b	3.50 b	3.50 c	4.25 b	1.25 a	5.50 ab
water drench	8.75 ab	8.50 a	8.75 a	9.25 a	8.50 a	2.00 a	10.50 a
water inject.	6.75 b	6.50 ab	7.50 a	6.25 b	6.50 ab	3.00 a	9.50 a
Sevin® XLR	0.25 c	0.00 c	0.00 c	0.50 d	0.75 c	1.75 a	2.50 b
F	27.77	17.63	32.79	28.43	18.50	0.99	5.64
Prob.	0.0001	0.0001	0.0001	0.0001	0.0001	0.4847	0.0046
Min. sig. diff.	2.45	3.0655	2.4431	2.3368	2.6268	3.6862	5.2293

Means followed by different letters in the same column are significantly different (P<0.05) using PC SAS analysis of variance and Tukey's studentized range test for mean separations.

Phytotoxicity Evaluations

Ant mounds treated with hot water injections were evaluated for phytotoxicity at 5 and 8 days post-treatment. A rating scale was used to describe damage to vegetation surrounding mounds:

1 = yellowing of some leaves, plant expected to recover completely,

2 = browning of some leaves, plant damaged but expected to recover,

3 = browning of most plant structures, plant seriously damaged or killed

	Average rating	
Plot no.	5-day	8-day
1	2.5	2.5
2	2.5	2.5
3	2.0	2.5
4	2.5	3.0

Evaluation of Queen Mortality

In an area adjacent to the individual mound treatment test, 20 mounds were flagged for evaluation of the effectiveness of hot water injections in immediately killing fire ant queens and winged female reproductive ants (alates). Ten mounds were treated with hot water injections while the remaining ten were untreated. Evaluations were conducted by digging up approximately 0.25 ft^3 of soil out of the center of each mound and spreading it out on a tarp. Three to five people then examined the debris and counted any live queens or female winged reproductives. Evaluations of the hot water-treated mounds was made one-half to one hour after treatment.

		No. of live queens/live female alates	
Mound no.		Treated	Untreated
1		0/0	3/0
2		0/0	0/1
3		0/0	0/1
4		0/0	0/0
5		0/0	0/2
6		0/0	0/0
7		0/0	0/0
8		0/0	4/1
9		0/0	0/2
10		0/0	0/4
	mean	0.0/0.0	0.7/1.1

Discussion and Summary

Results of the individual mound treatment test showed that the hot water injections eliminated ant activity in significantly ($P<0.05$) more treated mounds versus mounds treated with a water drench or left untreated at 5, 8, 15 and 30 days post-treatment. Hot water injections resulted in significantly fewer active mounds versus cold water injections of similar volume at 8 and 15 days post-treatment. The standard treatment, a one gallon/mound drench with 1.5 qt./100 gal. carbaryl, resulted in significantly fewer active mounds versus all other treatments at all evaluation dates.

New or satellite mound counts, conducted at 30 days post-treatment, showed no significant differences between treatments, though cold water injection plots had more new/satellite mounds. Carbaryl (Sevin) had significantly ($P<0.05$) fewer active mounds than the untreated, water-drenched or cold water-injected treatments when the total number of mounds (flagged + satellite) were analyzed at 30 days. Sevin and hot water-injection treatment plots contained statistically similar numbers of total active mounds, but the hot water injection-treated plots averaged more than double the number of active mounds than the Sevin-treated plots, 5.5 versus 2.5, respectively.

Phytotoxicity of hot water-injected mounds was fairly severe. Virtually all treated mounds had severely browned vegetation surrounding them, much of it appearing dead. Some mounds did appear to have vegetation with new growth appearing after 30 days.

Excavation of treated and untreated mounds revealed no live queens or female alates in treated mounds. However, in some treated mounds, ants were active around mound perimeters where there was no contact with hot water.

Results indicated that hot water injections immediately kill a large number of worker ants and any queens that are contacted by hot water. However, “control of treated ant mounds” averaged only about 60% over the course of the test. Observations showed that the ants would frequently abandon the main mound structure after injection, but rebuild a smaller mound immediately adjacent to the larger, original one. Observations taken at the 30 day evaluation show that, of the 17 mounds considered active, 9 contained brood and resembled a “normal” colony of reasonable size. The remaining 8 had either sufficient activity to be considered active or were of the small type located to the side of the original mound.

Re-invasion of plots was minimal and there were no significant differences, and small numerical ones, between treatments. The lack of new or satellite mounds indicates that both hot water injections and carbaryl treatments did, in fact, kill colonies, rather than re-locate them. Colony re-location, rather than mortality, is one of the main complaints consumers have about all fire ant control treatments.

The seemingly low rate of control by hot water injections is probably the result of two factors. The first and most important, is that these were multiple queen (polygyne) colonies. To achieve elimination of an ant colonies, *all* the queens would have to be killed within, perhaps, 10 minutes, the time needed to inject the hot water and for it to cool to a non-lethal temperature. Should a queen be deep in the soil or off to the side of the treated area, she would not be exposed to lethal temperatures.

The second factor is the large size of the mounds in this test site and the clay soil. Both of these conditions make the penetration of lethal-temperature water to all areas of the mound slower and more difficult. Though these conditions are found across much of Texas, they are rarely found in managed turf situations. Regular mowing simply does not allow such large mounds to build up. it is likely that control rates for smaller mounds, particularly in lighter soils, would be considerably better.

Finally, the cost of treating mounds must be taken into account. The cost of individual mound treatments range from a few cents to well over one dollar per mound. Bait products, costing $10-15 per acre, control roughly 90% of the mounds that are present in that acre. For instance if there are 100 mounds per acre (a moderate infestation), the cost is only $0.10 - 0.15 per mound. Sevin XLR is one of the least expensive individual mound treatment products available. At 1.5 quarts of Sevin XLR per 100 gallons, the cost is about $0.20 per mound, including labor at minimum wage, and mound control is greater than 90%.

The cost of materials for hot water injections are negligible - tap water and the fuel to heat it - but the initial investment in the equipment and, especially, the time it takes to treat mounds, is considerable. In this test, an average of about four gallons of water was applied to each mound, though the actual amount varied greatly. Consequently, it took an average of about three minutes to treat a single mound - a rate of only 20 mounds per hour.

In conclusion, hot water injections have a place in overall fire ant management, particularly in areas where very fast results and/or chemical-free treatments are desired. However, the economics of this method, particularly from a pest control operator perspective, must be seriously considered before adopting such a treatment method.