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ARE MULTIPLE QUEEN MOUNDS OF THE RED IMPORTED FIRE ANT MORE DIFFICULT TO CONTROL THAN SINGLE QUEEN MOUNDS?[1/]

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ABSTRACT

Single queen (monogynous) and multiple queen (polygynous) populations of the red imported fire ant, Solenopsis invicta Buren, were treated according to label directions with individual mound drenches containing chlorpyrifos. Percent reduction of marked mounds and mound densities were monitored. Polygynous mounds were rendered inactive somewhat more easily than monogynous mounds. Percent reduction of polygynous mound densities was initially reduced to a greater level, but resurgence of monogynous mounds was greater. Numerically, polygynous mound densities remained higher than those of the monogynous populations throughout the study period. In effect, more labor and insecticide was required to treat polygynous mound densities. The heavy insecticide use in the polygynous area may have reduced the resurgence of the polygynous mound densities as very few untreated sites existed for mound construction.

INTRODUCTION

The red imported fire ant (RIFA), Solenopsis invicta Buren, apparently entered the United States in the late 1930's or early 1940's (Buren et al. 1974) and was considered monogynous (single queen colonies) until the discovery of polygynous (multiple queen) colonies in Mississippi by Glancy et al. (1973). Soon after, polygynous colonies were reported from several sites in Texas (Hung, et al. 1974), Alabama, Florida, Georgia, and Louisiana (Fletcher 1983, Lofgren and Williams 1984).

Polygynous colonies differ in a number of parameters. Greenberg et al. (1985) reported that maximum head width of workers is greater in monogynous colonies (0.74 mm or more vs 0.71 or less in polygynous colonies) (Since then, less than 0.74 and more than 0.789 mm have been the headwidth parameters corrected by Greenberg with additional data (Pers. comm. L. Greenberg)). Mound density is higher in polygynous RIFA infested areas (approximately 300 mounds per 0.4 hectare (1 acre) vs rarely over 50 mounds per 0.4 hectare in areas infested with monogynous forms). A higher frequency of sterile males was reported from polygynous colonies (Hung et al. 1974).

Many anecdotal reports and "conventional wisdom" suggest that polygynous nests are more difficult to control than monogynous nests as all of the nest queens must be destroyed. Lammers (1987) found the survival of polygynous queens treated with an experimental juvenile hormone analog bait to be greater than monogynous colonies, suggesting that the polygynous form may be more persistent. We suspected that the use of individual insecticide mound drenches might be less effective on multiple queen colonies based on anecdotal reports which indicate the failure of products applied to areas with polygynous colonies. We compared the levels of control of the two forms of the ant in Texas using the insecticide chlorpyrifos.

MATERIALS AND METHODS

Two sites were selected for treatment: 1) a pasture infested with polygynous RIFA in Brazos County, TX, and 2) a pasture with suspected monogynous colonies in neighboring Montgomery County, TX. The pastures at both sites were similar in vegetative cover and both were lightly grazed. The site in Brazos County consisted of sandier soil. Worker ants from ten randomly selected mounds were collected from each site, and head widths were measured from a minimum of 25 worker ants from each mound before calculating average values for determining colony type (Greenberg et al. 1985). To further substantiate the type of RIFA in each location, ten colonies were collected from plot areas. Queen ants collected from each colony were dissected to observe the presence of sperm in the spermathaeca to determine if they were inseminated and reproductively active.

Circular plots were established in order to be able to monitor 1) activity in 30 individually marked mounds, and 2) density of active mounds on sampling dates before, one and approximately 10 weeks following treatment in each location. In Brazos Co., all mounds within a 0.05 hectare (1/8 acre) circle were mapped prior to treatment. In addition, 30 randomly selected mounds within the mapped area were marked and numbered with Kerr[R] canning jar lids nailed into the ground using 5 inch-long nails. All mounds within the mapped area were then treated with 7.39 ml (0.25 fl oz) chlorpyrifos (Dursban[R] 4E) in 3.79 liters (one gal) water using plastic sprinkler cans (Hamman et al. 1986). In addition, all mounds in a 3.0 meter (10 ft) wide area around the circular mapped area were treated to produce a mound-free "buffer" zone. Four treatment plots (replicates) were established, one each week beginning July 16, 1986.

A control plot, mapped and marked as described above, but in which mounds were drenched solely with 3.79 liters water was established and treated on the same days as the chemically treated plot. This plot was monitored weekly and served as the non-chemically treated control plot from which to compare the effects of insecticide applications in treated plots established weekly (replicated over time). Populations in this non-chemically treated plot remained relatively stable with few of the 30 marked mounds becoming inactive during the treatment to observation period. When marked mounds did become inactive, additional active mounds were marked and numbered for the following week's (next replicate's) evaluation.

RIFA mound densities were much lower in Montgomery County, requiring larger, 0.1 hectare (1/4 acre) plots. Three to six circular plots were required before 30 mounds could be mapped, marked and numbered. The resulting set of circular plots was considered to be a single replication. All mounds within mapped areas, plus those within a 3 meter buffer zone were treated as in Brazos County. Four sets of circular treatment plots were mapped and treated weekly beginning

July 14, 1987. One set of control plots were established, treated with water and monitored weekly in a fashion similar to the Brazos County location.

Mounds were monitored at one and eleven weeks after treatment using a minimal disturbance method: First, individual mounds were disturbed slightly to detect worker ant activity. If worker ants emerged in mass from the colony, that colony was determined active. If no activity was detected, the mound was further disturbed. The mound was determined to be inactive if no ant activity could be detected after severe disruption of the colony. This procedure resulted in a value for 1) the total number active mounds out of 30 originally marked mounds for each mapped plot or set of plots, and 2) the total number of active mounds per unit area which was converted to number of active mounds per acre.
Percent reduction of active RIFA mounds for each of the chlorpyrifos treated plots relative to their respective water-treated mound plots was derived for the 1 and 11 week post-treatment evaluations at each site by 1) calculating the percent negative difference in the number of active colonies from the 30 marked mound sets and 2) using Henderson's formula (Henderson and Tilton 1955) for the number of mounds per acre estimates. The Student's t test was used to separate mean worker head width as well as the mean percent control values derived to document any statistical differences between the two forms of RIFA.

The dimensions of the mounds differed between 30 randomly selected mounds measured from the Montgomery and Brazos County plots. Montgomery County plot mounds averaged 15.44 $\pm$ 5.08 cm in height. Height of mounds in Brazos County plots could not be accurately measured since they were low. Diameters of mounds from both areas were similar (46.36 $\pm$ 10.13SD cm in Montgomery County vs 50.11 $\pm$ 13.06SD cm in Brazos County). Differences in mound height may have been due to other factors such as soil type rather than to fire ant type. Soils in Montgomery County were hard black clay while hardened sand was predominant in the Brazos Co. plots. No rain occurred at either location during the establishment and one week post-treatment evaluation phases of this trial.

RESULTS AND DISCUSSION

Samples of worker ants randomly collected from 10 mounds from the Brazos County RIFA plots (August 7 and 22, 1986), showed that the population is predominantly (80 percent) polygynous (Table 1) with only two mounds (*) with an average head capsule size of over 0.74 mm. In addition, 80 percent of the mounds collected from the Brazos Co. plots with de-alate reproductive females contained more than one mated queen. The Montgomery County colonies sampled on July 3, 1986 were predominately (90 percent) monogynous (Table 1) with all but one (**) mound out of ten mounds sampled having an average worker head capsule size exceeding 0.74 mm. Furthermore, 25 percent of the mounds were found to contain a single mated female. The remainder contained numerous unmated de-alate females thought to have lost their wings after mounds were collected from the field. In the absence of the queen, female reproductives soon drop their wings (Fletcher and Blum 1981). Thus, the absence of mated females in these cases is interpreted as supportive evidence that these were monogynous mounds.

Table 2 presents the results of the treating four replicates of 30 marked mound sets of polygynous and monogynous mounds with 7.39 ml chlorpyrifos in 3.79 liters water per mound. No significant difference was found between the percent reductions of mounds between the two forms of ant colonies. The reduction in mound number in the controls of both forms were similar although more non-chemically treated mounds in Montgomery County became inactive. This may indicate that both forms respond similarly to natural mortality factors and perhaps that more movement of colonies from one mound site to another occurs in with monogynous forms.

The effect of mound drenches on the density of mounds is presented in Table 3. The density of polygynous mounds was 5 - 9 times the density of monogynous mounds in the control plots. Treatments reduced the number of mounds in both populations. The percent reductions was greater in the polygynous population at both 7 and 73+7 days with both populations showing a post treatment recovery by 73+ days (Table 4). Although not significantly different, recovery appeared greater in the monogynous populations (Table 4). The heavy insecticide use in the polygynous area may have reduced the resurgence of the polygynous mound densities as very few untreated sites existed for mound construction.

While chlorpyrifos drench treatments resulted in a greater percent reduction of polygynous mounds, because of the greater density, the absolute number of mounds per unit area remained 5 to 8 times greater post treatment (Table 3). The presence of 5 mounds per acre in the monogynous populations is generally tolerated better than 30 mounds per acre that remained in the treated polygynous area.

Other factors must be considered in evaluating treatment methods for control of polygynous vs monogynous RIFA populations, including labor, cost and environmental effect of product usage. Mixing, hauling and drenching individual mounds with a sprinkler can is labor intensive, particularly where a water source is remote. Obviously treating increased numbers of mounds in polygynous ant areas requires additional labor and time. Dursban^{R} 4E, containing 1.8 kg (4 lb) of chlorpyrifos per 3.79 liters (1 gal), retailed for $77.50 per gal in 1986. Brazos County polygynous mound densities required 640 individual mound drenches per 0.4 hectare (1 acre), using 1.25 gal Dursban^{R} 4E or 2.3 kg (5 lb) active ingredients per 0.4 hectare (1 acre) at a cost of $96.87. The Montgomery County only 29 individual mound drenches per 0.4 hectare were required to treat monogynous ant mounds, using 2.15 liters (0.57 gal) Dursban 4E or 0.11 kg (0.24 lb) active ingredients at a cost of $4.39. Current instructions on the product label do not allow for adjustments in the needed amount of active ingredient or water volume relative to mound size or S. invicta colony type. The label also does not suggest a maximum number of mounds to be treated per acre for economic purposes and in order to avoid excessive environmental contamination of areas treated.

Results obtained from using an individual mound drench to control monogynous or polygynous mounds of the RIFA in this experiment address the question, "Are multiple queen mounds of the red imported fire ant more difficult to control than single queen mounds?" The answer is not a simple 'yes' or 'no', as there are several different aspects which must be considered. Toxicologically, multiple queen RIFA mounds are as easy or easier to control than single queen mounds. From an analysis of percent control obtained with an individual mound treatment method of control, multiple queen mounds were eliminated to a significantly greater degree after one week than were single queen colony mounds, and resurgence was lower at 11 weeks. Numerically, however, multiple queen mound densities were consistently higher than those of single queen mounds to the point of being as numerous one week after treatment as were single queen colony mound densities prior to treatment. Furthermore, the labor, cost and amount of insecticide applied to the environment by treating multiple queen mounds renders the method used in this research impractical as a sole tactic for managing the polygynous RIFA.

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Table 1. Head capsule widths of red imported fire ant workers collected from 10 mounds in the Brazos and Montgomery County plots.

Brazos County	Montgomery County
0.7680*	0.8827
0.6250	0.8995
0.7164*	0.9782
0.7056	0.7214**
0.6408	0.8059
0.6920	0.8249
0.7992*	0.8112
0.6712	0.8011
0.6912	0.8309
0.7152*	0.8105
0.7025 ± 0.0527SD[1/]	0.8366 ± 0.0692SD[1/]

* indicates average worker ant head widths greater than 0.71 mm, indicating that these may not be polygynous colonies. The two that exceed 0.74 mm are considered to be monogynous.

** indicates average worker ant head widths less than 0.74 which may not be a monogynous colony.

[1/] Overall average head capsule sizes for each population were statistically different. Student's t test (t = -4.8762; P = 0.0001; DF = 18).

Table 2. Mean (± Standard Deviation) response of marked red imported fire ant mounds to treatments of 7.39 ml chlorpyrifos (Dursban[R] 4E) in one 3.79 liters water (treatment) and 3.79 liters water without insecticide (control) drenched on 4 replicates of 30 mounds in monogynous (Montgomery Co., Texas) and polygynous (Brazos Co., Texas) populations, 1986.

	Type of red imported fire ant population			
	Polygynous (Brazos Co.)		**Monogynous** (Montgomery Co.)	
	(PERCENT REDUCTION IN PARENTHESES[1/])			
Day after application	Treatment	Control	Treatment	Control
0	30	30	30	30
7	0	29.75 ± 0.5	0.25 ± 0.5	23.25 ± 6.5
	(100)		(99.05)	
73 ± 7	0	16	0.67 ± 0.58	13
	(100)		(96.16)	

[1/] Means of percent reduction of two forms are not statistically different at P≥5% using the Student's t test.

Table 3. Per acre population densities of polygynous and monogynous red imported fire ant mounds (± Standard Deviation) prior to and following individual mound applications of 7.39 ml chlorpyrifos (Dursban[R] 4E) per 3.79 liters water per mound (treatment) verses 3.79 liters water without insecticide (control), Brazos and Montgomery Co., Texas, 1986.

Treatment and day following application	Red imported fire and mounds per acre: Polygynous population[1/] (Brazos Co.)	Monogynous population[2/] (Montgomery Co.)
Control		
Pre-treatment (day 0)	487.00 ± 50.33	57.67 ± 16.59
Post-treatment (day 7)	606.00 ± 200.21	66.00 ± 14.94
Post-treatment (day 73 ± 7)	424.00	84.00
Treatment		
Pre-treatment (day 0)	640.00 ± 299.40	28.80 ± 7.58
Post-treatment (day 7)	30.00 ± 22.63	5.30 ± 3.55
Post-treatment (day 73 ± 7)	240.00 ± 22.63	29.08 ± 7.26

[1/] Means with Standard Deviation values of mounds per acre converted from mound counts of four circular one-eighth of an acre plots.

[2/] Means with Standard Deviation values of mounds per acre converted from mound counts of four replicates of three to six circular quarter-acre plots.

Table 3. Percent reduction in the density of monogynous and polygynous red imported fire ant mounds per acre (± Standard Deviation) following individual mound applications of 7.39 ml chlorpyrifos (Dursban[R] 4E) per 3.79 liters water per mound (treatment) verses 3.79 liters water without insecticide (control) calculated using Henderson's formula, Brazos and Montgomery Co., Texas, 1986.

Population type and location	Percent reduction in colony population density — Observation day following treatment: Day7	Day 73 + 7
Polygynous (Brazos[1/])	95.59 ± 2.68[3/]	59.78 ± 25.37[4/]
Monogynous (Montgomery[2/])	82.61 ± 11.00[3/]	29.86 ± 22.47[4/]

[1/] Means with Standard Deviation values for percent reduction of mounds per acre converted from mound counts of four circular one-eighth of an acre plots.

[2/]Means with Standard Deviation values for percent reductions of mounds per acre converted from mound counts of four replicates of three to six circular quarter-acre plots.

[3/]Statistically different means at $P \geq 5\%$ using the Student's-t test ($t = 2.2903$;$P = 0.0310$; DF = 6).

[4/]Not statistically different at $P \geq 5\%$ using the Student's t test ($t = 1.7655$; $P = 0.0640$; DF = 6).