Integrating Burning and Insecticide to Reduce Fire Ant Impacts on Bobwhite Chicks

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Hatching northern bobwhite (*Colinus virginianus*) chicks experience a low survival rate when exposed to a significant number of foraging red imported fire ants (*Solenopsis invicta*; RIFA). We initiated a study in southeastern Texas to determine if a reduced rate of insecticide and/or prescribed burning could decrease the foraging activity of RIFA below the threshold that causes mortality of northern bobwhite chicks. Research sites were divided into burned and nonburned plots and individual plots randomly received one of 4 rates of insecticide treatment: 0, 50, 75 or 100% of the recommended label rate (1.68 kg/ha) of Amdro® (hydramethylnon) insecticide bait (Ambrands, Atlanta, GA). Bait cup sampling of RIFA was conducted and differences in RIFA foraging activity were analyzed among treatments. As the rate of Amdro® application increased, RIFA foraging activity declined. Data from 2002 and 2003 revealed a difference in mean number of foraging RIFA in insecticide treated plots versus control plots ($P < 0.05$) when testing for the main effect of insecticide treatment. The mean number of foraging RIFA in 2002 decreased approximately 34%, whereas the mean number of foraging RIFA in 2003 decreased approximately 39%. In both years, the mean number of foraging RIFA collected in bait cups in burned plots was not different from nonburned plots ($P > 0.05$).

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Introduction

The red imported fire ant (*Solenopsis invicta* Buren; Hymenoptera: Formicidae) is an exotic species of particular concern to the southern United States. Extensive observational and experimental evidence has chronicled and quantified the expansion and subsequent environmental damage caused by *S. invicta* (Lofgren 1986). Ground nesting species such as northern bobwhite have received much attention due to the potential negative impacts from RIFA. Allen et al. (2000) reported a positive correlation between the years of RIFA infestation and bobwhite population declines in certain Texas counties. In addition, Mueller et al. (1999) recorded a lower survival rate among hatching northern bobwhite when exposed to RIFA assaults. Protecting the hatching bobwhite chicks from RIFA increased survival rate to 21 days of age. Furthermore, chick survival was directly related to the quantity (n = 300) of foraging RIFA captured within a 30-minute period in a standardized bait cup placed in the nests of northern bobwhites the day after hatch (Mueller et al. 1999). Controlling RIFA using insecticides appears to be a simple fix for the problem, but control methods for *S. invicta* have their limitations.

Methods for managing RIFA are expensive, labor intensive, and provide only temporary RIFA reductions. Numerous commercial insecticides are available for controlling RIFA such as Amdro® and Logic® insecticide baits (Collins et al. 1992). Chemical insecticides such as these offer some level of control, but are not economically feasible for most landowners to apply to large areas. Consequently, natural control methods for slowing RIFA activity are currently being investigated. Environmental dis-

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turbances such as prescribed burning may present a form of RIFA control. Forbes et al. (2002) observed a potential negative impact of prescribed burning on RIFA mound density. He hypothesized this negative impact was caused by reduced soil moisture and food availability that follows fire until regrowth occurs. Forbes et al. (2002) theorized that the negative consequences of burning on RIFA colonies were merely short term.

Prescribed burning is a relatively low cost management tool used to improve wildlife habitat. Implementing prescribed burning can specifically benefit northern bobwhite by encouraging forb production and controlling vegetation density in productive areas (Buckner and Landers 1979, Hansmire et al. 1988). Wright and Bailey (1982) suggested that protein-rich insects and seeds are plentiful in burned areas, providing important food resources for northern bobwhites. Prescribed burning could be utilized to increase the effectiveness of insecticide to negatively impact the foraging activity of RIFA. Literature quantifying RIFA responses to soil moisture and temperature following prescribed burning is limited. A thorough understanding of the relationships among these factors and prescribed burning would provide important information concerning the timing of the integration of burning and insecticide treatments to reduce RIFA foraging activity.

Managing, rather than eradicating RIFA is a strategy that can be used to reduce RIFA impacts on northern bobwhite chicks (Mueller et al. 1999). Mueller et al. (1999) reported a "threshold level" of foraging ants related to northern bobwhite chick survival. He reported that chick survival rates approached zero when chicks were exposed to 300 or more foraging RIFA. When the numbers of foraging RIFA fell below 300 ants per bait cup, northern bobwhite chicks were not threatened. This information is valuable because northern bobwhites may co-exist in RIFA-infested areas, but RIFA management is needed to improve chick survival. Our objective was to evaluate a management strategy using prescribed burning and/or a reduced amount of insecticide to decrease the foraging activity of red imported fire ants below the threshold level that causes mortality of northern bobwhite chicks. Chemical methods for managing RIFA can be costly for landowners, especially when applied to large areas. An integrated method combining a reduced amount of insecticide with prescribed burning addresses this problem of cost-effective RIFA control. Data from Forbes et al. (2002) and Mueller et al. (1999) prompted this study to examine integrated RIFA management using prescribed burning in conjunction with insecticide application. The goal of our research is to provide an economically viable management strategy to landowners for limiting RIFA impacts on northern bobwhite chicks.

Study Area

Research sites for this project were established in early spring 2002 and 2003 in actively cattle-grazed pastures. Study sites were selected based on the following criteria: adequate fine fuel load and continuous fine fuel to carry prescribed fires uniformly across research plots. Additionally, based on preliminary ant sampling, study sites displayed evidence of sufficient RIFA densities to recruit more than 300 RIFA using the standardized bait cup method (Mueller et al. 1999).

Research was conducted in Goliad and Victoria Counties, Texas in 2002 and Calhoun County, Texas in 2003. These counties are part of the Texas Coastal Prairie and consist of clay, clay loam, loam, and sandy loam soils with level to gently sloping landscapes. Dominant vegetation includes little bluestem (*Schizachyrium scoparim*), huisache (*Acacia smallii*), mesquite (*Prosopis glandulosa*), and prickly pear (*Opuntia lindheimeri*). The climate in these areas is humid and subtropical with mild winters. Average daily summer temperature is 28.5°C. Annual precipitation ranges between 78.74 and 113.18 cm (Miller 1982, Mowry and Bower 1978).

Methods

Research Plot Design

We established 8, 150 x 300-m blocks in spring 2002 in Victoria and Goliad Counties using a ran-

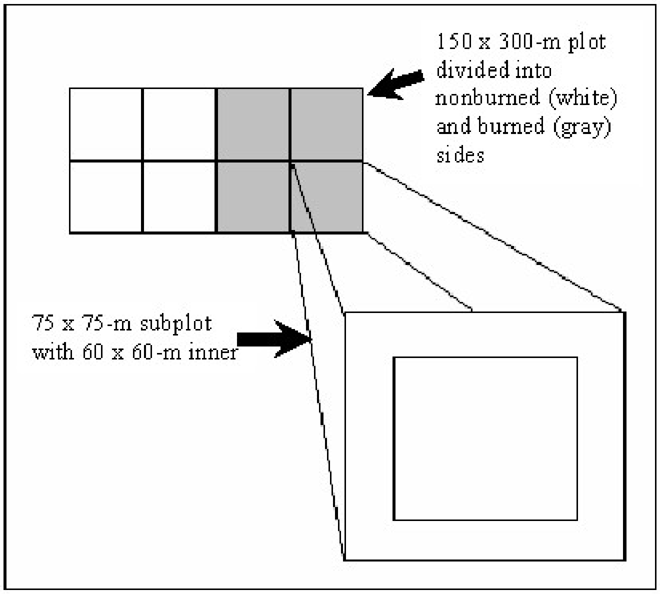

Figure 1: Research plot design.

domized block design. Each 150 x 300-m block consisted of 2, 150 x 150-m paired plots (1). One, 150 x 150-m plot within each block was randomly chosen for prescribed burning treatment. Subsequent to burning, each plot was stratified to create 4, 75 x 75-m subplots (8 subplots per block). We randomly selected each subplot to receive one of 4 rates of insecticide treatment: 0, 50, 75 or 100% of the recommended label rate (1.68 kg/ha) of Amdro® (hydramethylnon) insecticide bait (Ambrands, Atlanta, GA). For the purpose of this study, we define a "control" plot as receiving 0% of the label rate of Amdro®. We applied insecticide to a 60 x 60-m core area within each subplot to reduce impacts to adjacent treatment areas. Plot dimensions were developed based on the foraging distance of a fire ant colony. Subplot size was large enough to prevent invasion of the core area by ant colonies from outside the subplot (Mueller et al. 1999). Treatments were repeated in 2003 on 6 previously untreated plots in Calhoun County. We established only 6 research plots, or replicates, in 2003 due to an insufficient amount of burned area available.

Treatment Application

Prescribed burn treatments were randomly assigned to plots. Prescribed burn treatments were completed between January and March at all research sites during both years. We applied insecticide treatments following initial RIFA sampling. Application occurred during 10-15 May 2002 and 17-21 May 2003. We timed insecticide application to coincide ant control with peak bobwhite hatching season in southern Texas (Lehmann 1984). Amdro® was applied using a Herd GT-77 broadcast spreader (Herd Seeder Company, Inc., Logansport, IN) mounted to the rear of a Yamaha ATV (Yamaha Motor Corporation, U.S.A.). In 2002, we controlled differences in the rate of insecticide application by varying ATV speed. These applications were calibrated by measuring the effective swath width of the spreader and the weight of insecticide delivered over a 50 m distance at different speeds. This insecticide application method was modified in 2003 to reduce the risk of driving the ATV at high speeds across uneven terrain. While the application method was modified during 2003, the individual application rates remained the same. In 2003, to insure

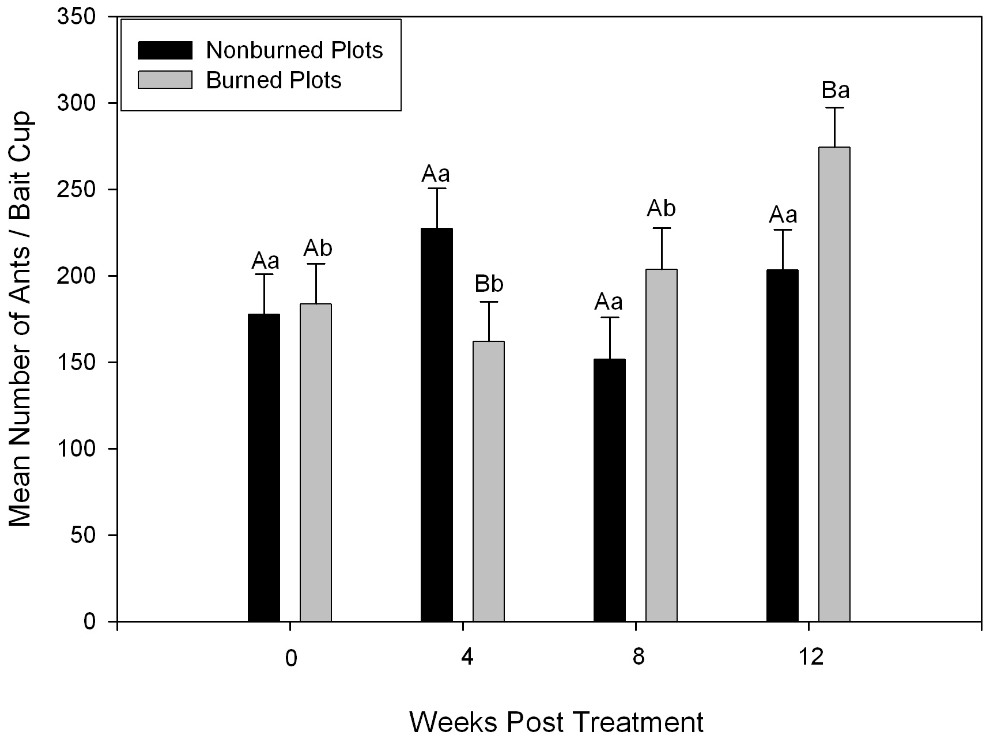

Figure 2: Mean (±SE) number of foraging RIFA collected in bait cups from burned and nonburned plots in Goliad and Victoria Counties, Texas, in 2002. Means within a sampling time followed by the same upper case letter are not significantly different ($P > 0.05$). Means within a burning treatment followed by the same lower case letter are not significantly different ($P > 0.05$).

uniform distribution across the entirety of each subplot, we mixed each individual rate of insecticide with Quaker® corn grits (Quaker Oats Company, Chicago) to provide a total mixture (Amdro® and Quaker® corn grits) weighing 0.91 kg. This mixture weight is the amount delivered when traversing the entire core area of the subplot (at the effective swath width) 1 time at 9.7 km/h. Since corn grits comprise approximately 75% g/g of Amdro® insecticide bait, the additional corn grit effectively diluted the concentration of insecticide without fundamentally changing the bait. This allowed for the reduced speed of the ATV while still achieving the same insecticide application rate.

Ant Sampling

Efficacy of treatments on RIFA foraging activity within the core area of each subplot was evaluated using a bait cup method as previously described (Porter and Tschinkel 1987, Mueller et al. 1999). A hotdog bait (approximately 5-mm slice) was placed inside a 28.4 ml plastic cup and then positioned on bare ground. We took a random number of steps out into each subplot core area and placed 5 bait cups approximately 10 meters apart along a diagonal transect. After 30 minutes, the plastic bait cup, including all ants contained inside, was collected and placed in a specimen container. Ant samples were placed in alcohol until specimens could be identified and counted. Bait cup sampling was conducted immediately prior to insecticide treatment, 4 weeks, 8 weeks, and 12 weeks after treatment. In 2002, ant sampling occurred during 10-15 May, 10-13 June, 8-11 July, and 5-8 August. In 2003, ant sampling occurred during 17-21 May, 16-19 June, and 11-

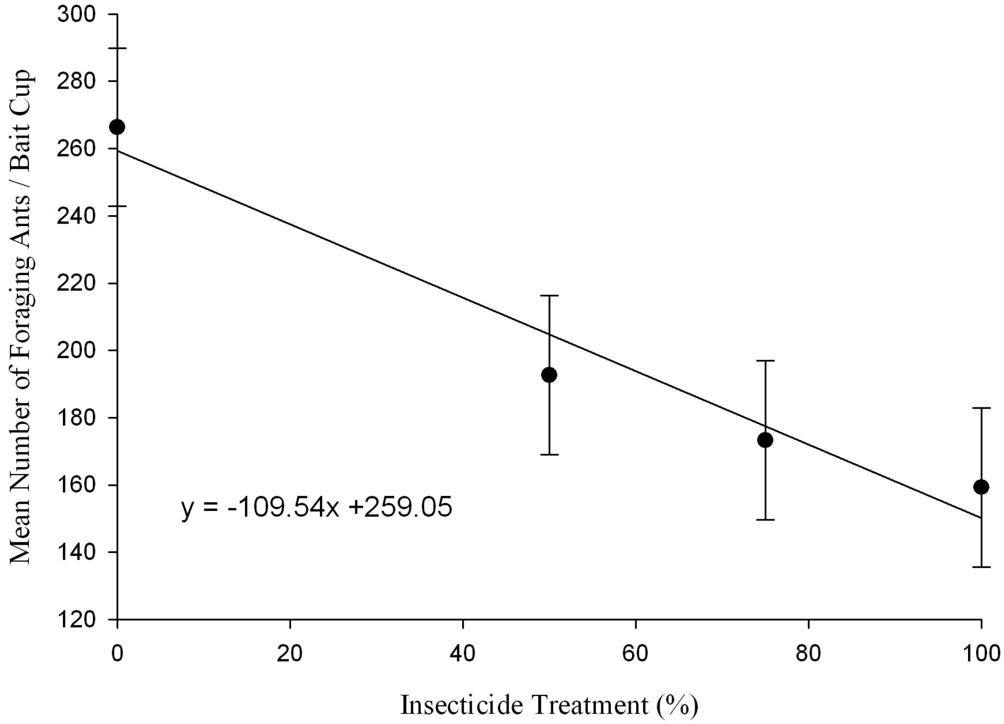

Figure 3: Mean (±SE) number of foraging RIFA collected in bait cups plotted against percent label rate of Amdro®insecticide treatment. Ants were collected from plots in Goliad and Victoria Counties, Texas, in 2002.

14 August. We could not sample ants 8 weeks post-treatment in 2003 due to Hurricane Claudette; therefore, there is no data for that sampling time. Ant sampling occurred between 0800 hours and 1200 hours, with air temperatures ranging between 21°C and 32°C, and soil temperatures ranging between 22°C and 31.67°C.

Data Analysis

We used a randomized block design to analyze the data. The variable of interest was mean number of foraging RIFA collected in bait cups. Differences in RIFA foraging activity among treatments were assessed a using two-factor repeated measure ANOVA with burning and insecticide as the two main factors. Differences among individual means were determined using the least squares method. The relationship between insecticide application rate and mean number of foraging RIFA collected in bait cups was evaluated using linear regression.

Results

2002 Results

In 2002, the mean number of foraging RIFA collected in bait cups in burned plots did not differ from unburned plots (ANOVA, F = 1.14, df = 1, P = 0.2864). In addition, any differences observed among the simple main effects were not consistent (2). For example, RIFA means 0 and 8 weeks post-treatment were not different between burned and nonburned plots. However, RIFA means were lower in burned plots as compared to nonburned plots 4 weeks post-treatment, but higher 12 weeks post-treatment. Furthermore, no differences were detected among nonburned plot means throughout the sampling period in 2002 (2). The mean number of foraging RIFA collected in bait cups was different among sampling times (ANOVA, F = 3.64, df = 3, P

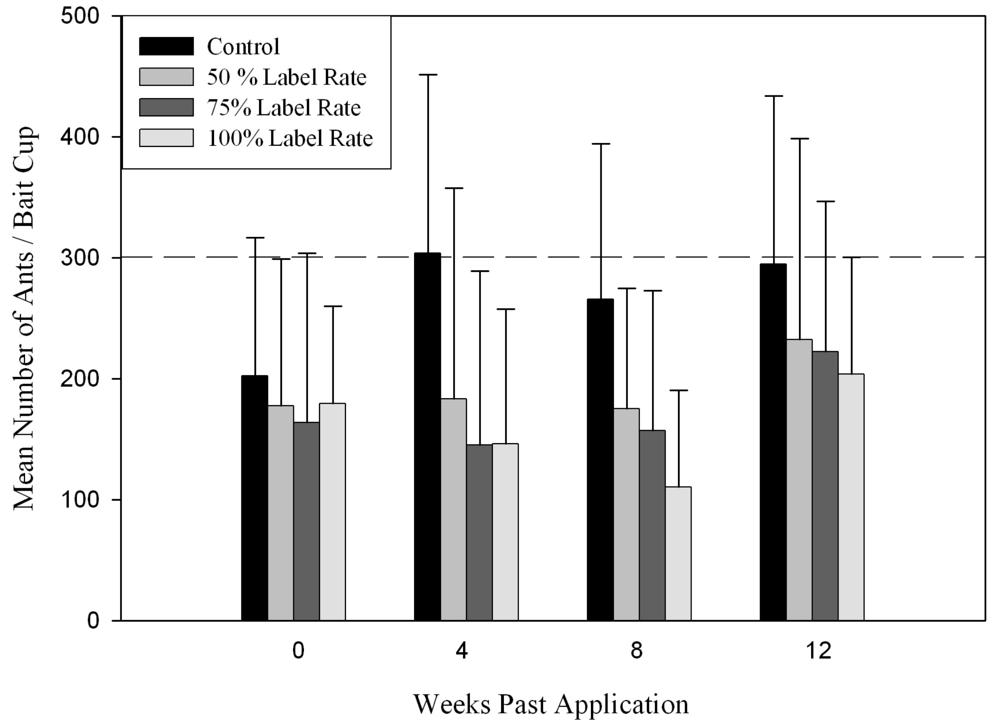

Figure 4: Mean (±SE) number of foraging RIFA collected in bait cups for each insecticide treatment within four different sampling periods. Dashed line indicates threshold level of 300 foraging ants. Ants collected from plots in Goliad and Victoria Counties, Texas, in 2002.

= 0.0136). However, an interaction occurred between burning treatments and sampling times (ANOVA, F = 4.29, df = 3, P = 0.0058); therefore, variations over time were different in burned and nonburned plots.

Insecticide treatment application rate was negatively related to the mean number of foraging RIFA (F = 30.06, df = 1, $P < 0.0001$; 3). The mean number of foraging RIFA collected in bait cups was different in insecticide-treated plots versus control plots (zero percent insecticide application rate) (ANOVA, F = 10.49, df = 3, $P < 0.0001$) when testing for the main effect of insecticide treatment. However, individual insecticide application rate means were not different from each other (4). Each standard deviation bar for the control means exceeded 300 foraging ants (threshold level for bobwhite chick survival). Furthermore, each insecticide mean fell below this threshold level of 300 foraging ants.

2003 Results

The results from 2003 were similar to 2002. In 2003 the mean number of foraging RIFA collected in bait cups in burned plots did not differ from unburned plots (ANOVA, F = 0.13, df = 1, P = 0.7387; 5). Fire ant foraging means differed among sampling times (ANOVA, F = 77.51, df = 2, $P < 0.0001$). The mean number of foraging RIFA decreased as time increased. As in 2002, insecticide treatment application rate was negatively related to the mean number of foraging RIFA (F = 7.53, df = 1, $P < 0.0105$; 6). The mean number of foraging RIFA collected in bait cups was different in insecticide-treated plots versus control plots (ANOVA, F = 2.88, df = 3, P = 0.05) when testing for the main effect of insecticide treatment. However, means of individual insecticide application rates were not different from each other (7). Each standard deviation bar for the control means

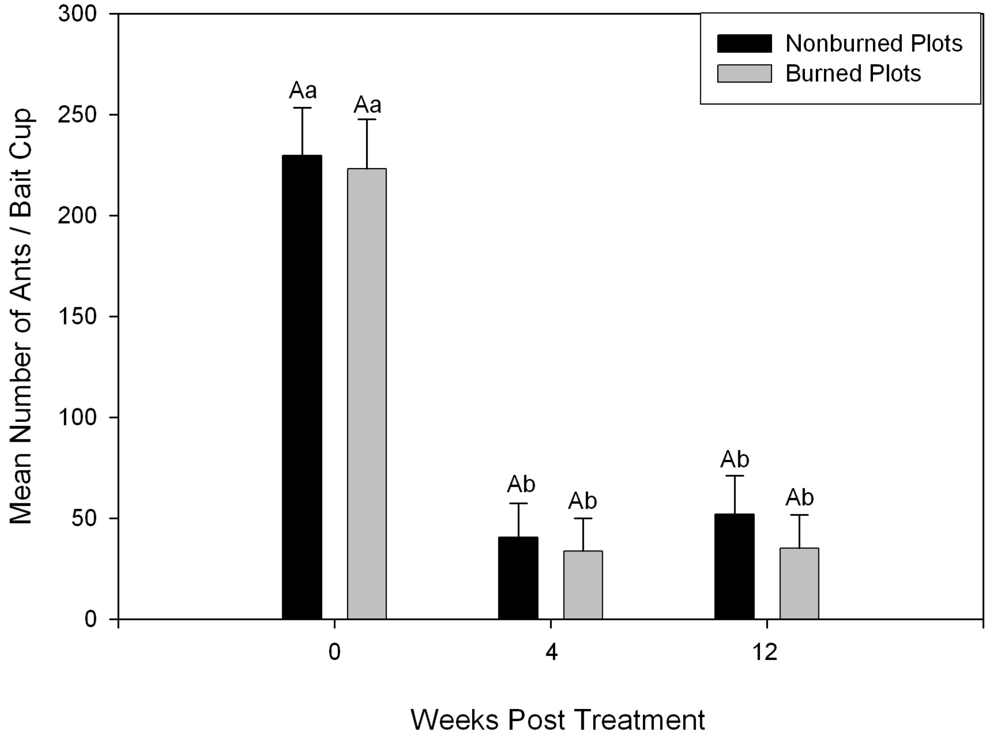

Figure 5: Mean (±SE) number of foraging RIFA collected in bait cups from burned and nonburned plots in Calhoun County, Texas, in 2003. Means within a sampling time followed by the same upper case letter are not significantly different ($P > 0.05$). Means within a burning treatment followed by the same lower case letter are not significantly different ($P > 0.05$).

exceeds 300 foraging ants (threshold level for bobwhite chick survival). Furthermore, each insecticide mean fell below this threshold level of 300 foraging ants.

Discussion

Red imported fire ant foraging activity was reduced by Amdro® insecticide treatments. As the rate of Amdro® increased, foraging activity of RIFA declined. Our results are similar to Apperson et al. (1984) who reported that Amdro® was effective in decreasing the number of foraging RIFA workers. In 2003, RIFA foraging means decreased considerably between 0 weeks post-treatment and 4 weeks post-treatment. This change is much greater than what was observed during these same time periods in 2002. Variation in foraging activity is most likely due to environmental conditions during insecticide application. Lack of foraging activity can be attributed to reduced soil moisture or unsuitable soil temperatures (Porter and Tschinkel 1987). Foraging means in 2003 are also much lower in 12 weeks post-treatment compared to 2002 data. Hurricane Claudette might explain this shift in foraging activity. Hurricane Claudette hit the Texas coast in July 2003 (8 weeks post-treatment). This extreme weather event could have negatively impacted RIFA populations by reducing their foraging activity and causing dispersal from low lying areas (Rhoades and Davis 1967).

In our study, Amdro® was successful in decreasing RIFA foraging activity below the threshold level of 300 ants per bait cup (Mueller et al. 1999). Controlling RIFA activity below this threshold level has

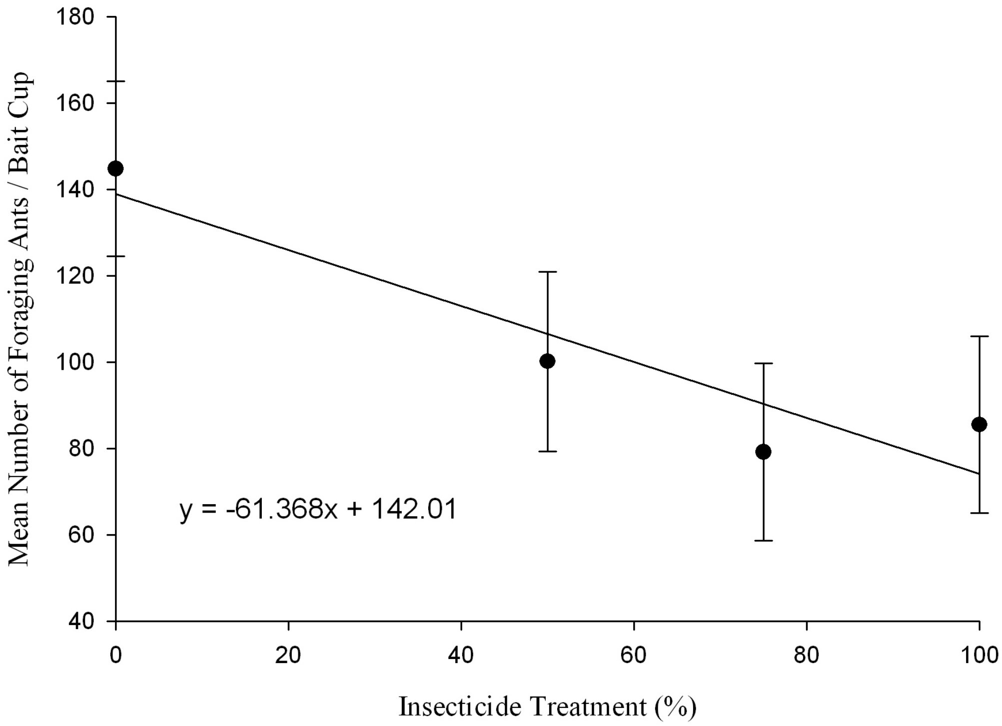

Figure 6: Mean (±SE) number of foraging RIFA collected in bait cups plotted against percent label rate of Amdro®insecticide treatment. Ants were collected from plots in Calhoun County, Texas, in 2003.

been positively related to bobwhite quail chick survival (Mueller et al. 1999). It is especially important to note that all three rates of Amdro (50%, 75%, and 100%) were equally effective in achieving this objective. Our study produced similar results as earlier research that examined the effectiveness of reduced rates of insecticides. Drees et al. (1993) found that a reduced rate of Logic® insecticide is as effective in suppressing RIFA as the full rate.

Our data indicate that a reduced rate of Amdro® insecticide is as effective as using a full label rate for reducing RIFA foraging activity and their impacts on northern bobwhite chicks in a Texas coastal prairie environment. This outcome is important to landowners who want to manage their land for northern bobwhite by controlling RIFA activity. Using a reduced rate of insecticide to decrease RIFA activity equates to lower management costs. For example, a landowner who uses 50% of the recommended label rate of Amdro as opposed to the full rate is able to treat twice as much land at the same cost. A 25-pound bag of Amdro insecticide has a retail cost of $250 (2003, personal observation in Lubbock, TX). Treatment cost, excluding labor and equipment, is approximately $37.00 per hectare when using 100% of the label rate of Amdro (1.68 kg/hectare). In comparison, when using 50% of the label rate of Amdro it costs approximately $18.50 per hectare to treat for RIFA.

Burning combined with insecticide application provided no additional benefit to insecticide application alone for decreasing RIFA foraging activity. Therefore, when landowners are attempting to control RIFA activity to benefit bobwhite chick survival, our data suggest there is no additional benefit to use prescribed burning. We initially theorized that using fire combined with insecticide application would significantly reduce RIFA foraging activity.

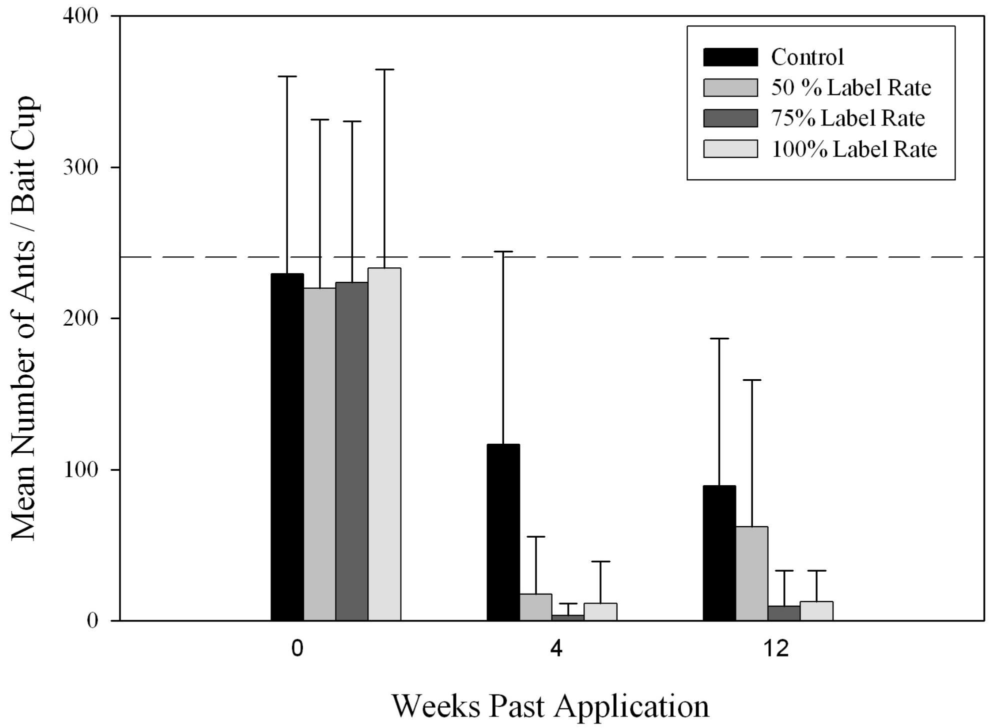

Figure 7: Mean (±SE) number of foraging RIFA collected in bait cups for each insecticide treatment within 3 different sampling periods. Dashed line indicates threshold level of 300 foraging ants. Missing data in 8 weeks post treatment due to hurricane. Ants collected from plots in Calhoun County, Texas, in 2003.

Although we found no decrease in RIFA following a prescribed burn treatment, we also did not see any increase in ant numbers.

No differences in burning versus nonburned treatment means could be explained by a number of factors. Forbes et al. (2002) hypothesized that prescribed burning negatively impacts RIFA because of reduced soil moisture and food availability that follows fire, until regrowth occurs. It is possible that the burns conducted for this study did not burn hot enough to make substantial impacts on forage availability or soil moisture. Another reason might be attributed to the RIFA recolonization success. Red imported fire ant colonies affected by these fires might have had adequate time to recover before the impacts of the insecticide took affect. Limited research is available on the effects of fire on *S. invicta*. Additional research is needed to better understand the relationship between habitat disturbances such as fire and RIFA activity.

Red imported fire ants can cause serious problems for wildlife such as northern bobwhite. Chicks are especially sensitive to RIFA activity and can benefit from fire ant control (Mueller et al. 1999). Eradication is not required to reduce RIFA impacts on bobwhite chicks, although RIFA control on some level is important (Mueller et al. 1999). Control methods need to be effective yet affordable for landowners. One of our objectives was to evaluate a more economical way for landowners to control RIFA impacts on northern bobwhite chicks. Our results suggest that using a reduced rate of Amdro® insecticide is effective in reducing RIFA foraging activity. Using a reduced rate of insecticide has a cost benefit for landowners treating for RIFA, but additional economic analysis of RIFA control is needed.

Eradication of RIFA may be an unrealistic goal; therefore, it is important to continue research to develop effective management strategies that will reduce RIFA impacts on important wildlife species such as the northern bobwhite.

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