DOES HABITAT MANAGEMENT FOR NORTHERN BOBWHITES BENEFIT THE RED IMPORTED FIRE ANT?

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ABSTRACT

Red imported fire ants (*Solenopsis invicta*) have caused damage to agricultural, economic, and wildlife resources since their accidental introduction. Previous studies have suggested that red imported fire ant (RIFA) mound densities are positively correlated to habitats maintained through disturbance. Prescribed burning and disking are two techniques commonly used to disturb portions of the landscape to maintain early successional habitats for northern bobwhite (*Colinus virginianus*). We tested the hypothesis that prescribed burning and disking would increase RIFA mound densities. This study was conducted in Refugio County, Texas in the Texas Coastal Prairie on Loamy Prairie range sites. Red imported fire ant mound densities were different between years ($F = 5.05$, $df = 2$, $P = 0.0148$). However, burning and disking had no impact ($F = 0.22$, $df = 2$, $P = 0.8044$) on RIFA mound densities. Initially high RIFA mound densities in our study area coupled with the territoriality of predominantly monogyne (single-queen) colonies may have limited increases in RIFA mound density in response to treatments on these study sites.

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INTRODUCTION

The red imported fire ant has become a significant ecological, economic, and human health concern in the United States since its accidental introduction in the late 1930s at the port of Mobile, Alabama. Red imported fire ants are predicted to eventually occupy more than 25% of the United States (Vinson and Sorenson 1986). Their negative impact on agricultural and economic resources is well documented (Adams et al. 1976, 1977, 1983, 1988, Brinkley 1989). Red imported fire ants also have a detrimental impact on our wildlife resources (Ridlehuber 1982, Sikes and Arnold 1986, Lockley 1995, Allen et al. 1997).

Predominantly terrestrial species, such as northern bobwhites are particularly susceptible to impacts of RIFA. Northern bobwhite populations in 15 Texas counties were negatively correlated with years of RIFA infestation (Allen et al. 1995). Red imported fire ants reduced survival of northern bobwhite chicks to 3 weeks of age by 38% in the Texas Coastal Prairie (Mueller et al. 1999).

Red imported fire ant populations can be significantly reduced using broadcast applications of insecticide baits such as Amdro® (American Cyanimid, Wayne, New Jersey). However, this treatment is not economically feasible for many landowners, particularly those with larger tracts of land (Drees 1998). Until an economically feasible method to control RIFA over large areas is available, we must attempt to slow the invasion of RIFA and prevent increases in population densities on currently colonized areas. Therefore, it is important that we examine whether current land management practices are benefiting RIFA populations, and thus possibly degrading habitat for northern bobwhites and other wildlife species.

Disking and prescribed burning are often used to enhance habitat for early successional wildlife species such as northern bobwhites. Disking breaks up most dense grasses and, to a lesser extent, shrubs. Forb growth is stimulated, which provides food for northern bobwhite (Buckner and Landers 1979, Webb and Guthery 1983). Invertebrate biomass, an important protein source for northern bobwhite chicks, increases in response to disking (Robel et al. 1996). Additionally, disking creates travel lanes through thick cover

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and provides edge between grasses and bare ground, which is beneficial to nesting hens (Guthery 1986:71).

Prescribed burning is one of the least expensive habitat manipulation techniques used to manage habitat for northern bobwhites (Guthery 1986:75). In Texas, prescribed fire application costs between $7 and $18 per ha on juniper-infested rangeland (Mitchell et al. 2000). Fire favors many species of forbs, which are preferred northern bobwhite foods (Hansmire et al. 1988, Masters et al. 1995). Burning also encourages the growth of grasses such as *Panicum* spp. and *Paspalum* spp. (Wright and Bailey 1982:58). These grasses provide winter food and to a lesser extent, cover for northern bobwhites (Lehmann 1984:81). Formerly avoided as a management practice, prescribed burning is becoming an accepted and valuable tool for wildlife habitat enhancement.

While both disking and burning improve habitat quality for early successional wildlife species, they may also make habitat more suitable for RIFA. Red imported fire ant mound density has been positively correlated with habitats maintained via disturbance (Tschinkel 1988, Stiles and Jones 1998). Consequently, management practices used to benefit early successional species may increase RIFA and lessen or even negate the desired benefits of habitat manipulations. We tested the hypothesis that prescribed burning and disking would increase RIFA mound densities in the Texas Coastal Prairie.

METHODS

Study Area

Our study was conducted in Refugio County, Texas. Climate is subtropical, with dry, mild winters, and hot, humid summers (Guckian 1988). Average annual precipitation is 97 cm, with 60% typically occurring between April and September (Guckian 1988). Soils are moderately deep to deep, loamy soils on nearly level uplands of the Faddin (Abruptic Argiaquolls) and Wyick (Typic Albaqualfs) series (Guckian 1988). The range site is loamy prairie, with a climax vegetation dominated by grasses including little bluestem (*Andropogon scoparius*), sideoats grama (*Bouteloua curtipendula*), and various *Paspalum* species. Dominant forbs include partridgepea (*Cassia fasiculata*) and various Croton (*Croton* spp.) species. This vegetation is typical Texas Coastal Prairie (Gould 1975), although honey mesquite (*Prosopis glandulosa*) and huisache (*Acacia smallii*) have invaded some areas.

Experimental Design

This study utilized a completely randomized design, with 3 treatments (prescribed burning, disking, and control) and 5 replicates. The experimental units were 150 × 150 m plots of Texas Coastal Prairie infested with RIFA. Other consistent characteristics across plots were sandy loam soils, adequate fine fuel load, and continuous fine fuel to carry prescribed fires uniformly across the plots. Each plot received 1 of the following randomly chosen treatments: prescribed burning, disking, or control. A 7-m disked strip was installed on the perimeter of plots to serve as firebreaks for plots where prescribed burns were conducted. Each experimental unit was bordered by a 7-m disked strip to minimize possible variation associated with the firebreaks.

Application of Treatments

Habitat treatments were applied after pre-treatment RIFA mound censuses were conducted. Each treatment was randomly assigned to 5 plots. Prescribed burns were conducted on 2 March 1998 using the strip headfire ignition technique (Wright and Bailey 1982:426). Fine fuel loads on the burned areas ranged from 2340 to 3170 kg/ha. Fire intensity was low, with ambient air temperatures of 21–24°C, relative humidities of 32–42%, and light winds (4–10 km/h). Disking treatments were applied with 1 pass of a 7-m wide disk pulled behind a tractor. Eight strips were disked on each plot in a parallel fashion, covering approximately 40% of the plot. Disking was conducted the last week of February and the first week of March 1998.

RIFA Sampling

Within each plot, a 100 × 100 m core area was delineated in the middle of each treatment area. We estimated RIFA mound densities before burning and disking in January–February 1998 within the core areas using distance sampling (Buckland et al. 1993, Forbes et al. 2000). Nine, 100-m transects were sampled within each core area. The first transect was randomly placed 5 to 15 m from a randomly chosen side of the core area. The remaining 8 transects were set parallel to the previous transect at 10-m intervals. Each transect was evaluated by 2 observers, and all RIFA mounds detected within a 5-m perpendicular distance from the transect line were recorded. Red imported fire ant mound densities were calculated using the program DISTANCE (Laake et al. 1996, Forbes et al. 2000). After burning and disking, RIFA mound densities were estimated in June–July 1998, and May–June 1999 using the same method.

To determine whether RIFA colonies within the sampling area were monogyne (single queen) or polygyne (multiple queens), RIFA workers from a total of 100 randomly chosen mounds were collected within the core areas before treatment. Approximately 50 workers were collected from each mound. Head capsule widths were measured on 15 randomly selected workers from each mound. Red imported fire ant mounds were classified as monogyne or polygyne based upon the guidelines established by Greenberg et al. (1985).

Data Analysis

Red imported fire ant mound density data were analyzed using a repeated measures analysis of variance (ANOVA) with Statistical Analysis Systems (SAS) software (SAS 1985). Data were log-trans-

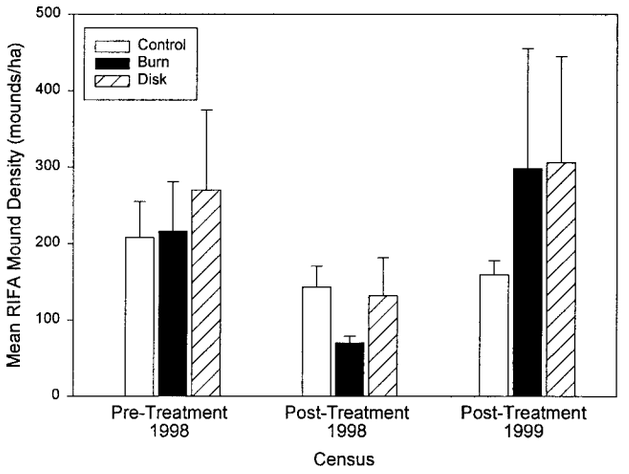

Fig. 1. Mean RIFA mound densities (± SE) within treatments in Refugio County, Texas in 1998 and 1999.

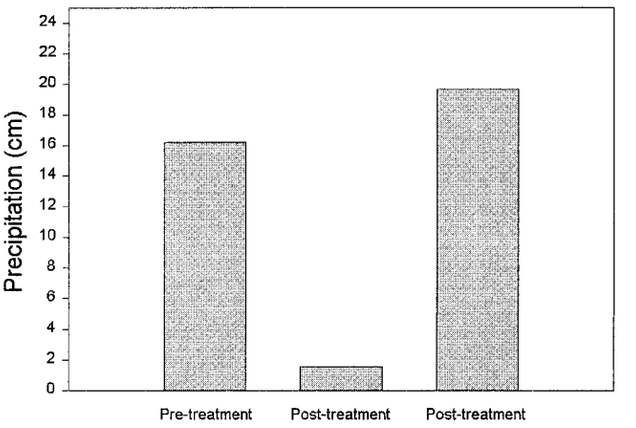

Fig. 2. Three month precipitation totals prior to RIFA mound surveys in Refugio County, Texas in 1998 and 1999.

formed to satisfy assumptions of normality, homogenous variances, and sphericity. However, results of ANOVA on log-transformed data were not different from that of non-transformed data. Therefore, results are presented using actual RIFA mound densities, as results are more easily interpreted. Differences in percentage of polygyne colonies among treatments were analyzed using a one-way ANOVA. Linear regression was used to determine the relationship between percentage of polygyne colonies and RIFA mound density (SAS 1985). Significance was assessed at $\alpha = 0.05$. Means are reported as ± 1 SE.

RESULTS AND DISCUSSION

Red imported fire ant mound densities were extremely variable throughout treatments, ranging from 46.3 mounds/ha to 893.0 mounds/ha over the 2 years of the study (Fig. 1). Red imported fire ant mound densities were different between years ($F = 5.05$, $df = 2$, $P = 0.0148$), but not among treatments ($F = 0.22$, $df = 2$, $P = 0.8044$). Temporal differences are likely explained by the extreme difference in precipitation in the 3 months leading up to and including the month during which RIFA mounds were censused (Fig. 2). Precipitation was similar to the long-term mean during pre-treatment counts in 1998 and post-treatment counts in 1999, but extreme drought conditions were prevalent during the post-treatment counts in 1998 (National Oceanic and Atmospheric Administration 1998, 1999). This likely caused RIFA to move deeper into the soil as water content declined near the surface (Lofgren et al. 1975), making smaller RIFA mounds more difficult to detect, resulting in lower mound density estimates.

One possible explanation for the lack of RIFA response (i.e., changes in RIFA mound densities) to treatments relates to whether mounds were predominantly monogyne or polygyne. Porter et al. (1991) estimated that polygyny occurs at a rate of approximately 54% in Texas. Red imported fire ant mounds sampled within plots on this study were 32 ± 7% polygyne, and percent polygyny did not differ among treatments ($F = 0.407$, $df = 2$, $P = 0.6750$). Mean RIFA mound density estimates prior to treatment application were 231.37 ± 41.37 mounds/ha, which is very close to the maximum density at which monogyne colonies will occur (Vinson and Sorenson 1986, Porter and Tschinkel 1988, Porter et al. 1992). Red imported fire ant mound densities in previous studies which have linked RIFA populations to disturbance were conducted in areas where mound densities were as low as 8.8 mounds/ha (Tschinkel 1988, Stiles and Jones 1998). In the current study, RIFA mound densities were already close to the maximum density for monogyne colonies. Consequently, application of treatments may not have increased RIFA mound densities because RIFA mounds were already near the maximum densities permitted by their territorial behavior. Red imported fire ant mound densities in 1999, 1 year after treatment applications, were related (*a posteriori*; $R^2 = 0.8392$, $P < 0.0001$) to percent occurrence of polygyny (Fig. 3). Responses of RIFA colonies to habitat treatments in areas where mounds are

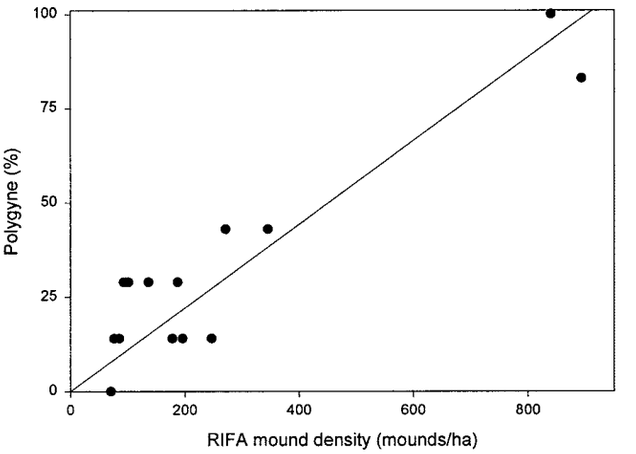

Fig. 3. Linear regression of RIFA mound densities against % occurrence of polygyny within sampling areas in Refugio County, Texas in 1998 and 1999 ($R^2 = 0.8392$, $P < 0.0001$).

predominantly polygyne may differ, due to their decreased territoriality.

CONCLUSION

This study examined the effects of burning and disking on RIFA populations in the Texas Coastal Prairie. Red imported fire ants occupy many different habitats throughout the southeastern and Gulf Coast regions of the United States. The effects of burning and disking (and/or other habitat management techniques) on RIFA populations is largely unknown in these other habitats. In many instances, eradication of RIFA is biologically and economically unfeasible. Although this study indicates prescribed burning and disking do not increase the mound densities of predominantly monogyne colonies of RIFA in the Texas Coastal Prairie, it is important to determine that wildlife management practices in other regions are not causing conditions to become more favorable for RIFA, and thus less favorable for wildlife.

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