EFFECT OF PRO-DRONE, AN INSECT GROWTH REGULATOR, ON SOLENOPSIS INVICTA BUREN\textsuperscript{1} AND NONTARGET ANTS\textsuperscript{2}

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ABSTRACT

An insect growth regulator, Pro-Drone \([1-(8\text{-}methoxy\text{-}4,8\text{-}dimethyl-9\text{-}nonyl})\text{-}I\text{-}(I\text{-}methylethyl) benzene\], was aerially applied twice at the rate of 11.86 g AI/ha on ca. 200,000 ha in Kendall and Kerr Cos., Texas, during 1983 to control the red imported fire ant, Solenopsis invicta Buren. The first application was made between 10-20 June and the second application between 26 September - 1 October. To determine the impact of the insect growth regulator on \(S.\) invicta and common nontarget ants, the ant fauna in the test area was monitored monthly in four distinct ecological communities by pitfall trapping for one year, beginning 5 wks pretreatment. Treatment did not significantly affect species richness, the number of species present, the number of species present from particular subfamilies, nor the number of ants present from the eight most common species. Results indicate that Pro-Drone had no significant effect on the local ant fauna.

INTRODUCTION

More than 3,000 chemicals have been evaluated for control of the red and black imported fire ants, Solenopsis invicta Buren and Solenopsis richteri Forel, since Congress initiated the Federal-State Cooperative Imported Fire Ant Eradication Program in 1957 (USDA 1976). Of the compounds tested, the most effective were the diene-organochlorine insecticides. However, environmental persistence and harmful effects of the cyclodiene on nontarget organisms led the Environmental Protection Agency to cancel their registrations, including Mirex in 1978 (Banks and Schwarz 1980). Since then, research has been aimed at finding alternative control agents. Insect growth regulators (IGRs) with juvenile hormone activity are being investigated. Although these compounds are nontoxic to \(S.\) invicta adults, they do cause deformities in the larvae which are subsequently expressed in the adults. These IGRs have been found to influence \(S.\) invicta fecundity, metamorphosis, and caste determination (Banks et al.

\textsuperscript{1}Hymenoptera: Formicidae.

\textsuperscript{2}This paper reports the results of research only. Mention of a proprietary product does not constitute endorsement or recommendation for its use by either Texas Tech University or the Texas Department of Agriculture.

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Maximum possible times detected: 96 (8 sites sampled monthly for 12 months). Each trap is a subsample of the transect.

Unable to identify to species.

1978, Banks and Schwarz 1980, Banks et al. 1983). IGR-induced deformities, death of developing larvae, and a shift in caste differentiation from worker to sterile reproductive forms causes cessation of worker replacement, resulting in death of the colony (Banks et al. 1983). Of 26 IGRs tested for efficacy against both laboratory and field colonies of S. invicta, Al3-36206 [also known as USDA (BANPAL) MS-10-160b] has shown considerable effect. This compound caused 80% colony mortality (n = 20) in laboratory tests, with the time of death ranging from 14-68 wks postapplication (Banks et al. 1983). Subsequently, this compound (1-(8-methoxy-4,8-dimethylnonyl)-4-(1-methyl) benzene), developed under the name Pro-Drone, reduced S. invicta populations in Florida by 64 and 76% for one year on 1.4 and 1.8 ha field plots, respectively (Banks and Schwarz 1980). Those plots were treated with 10.5 and 4.75 g Al/ha, with the lower rate resulting in the higher percentage of kill. In addition, Phillips et al. (1985) reported that Pro-Drone applied to ca. 53,000 ha in southeastern Texas at the rate of 11.86 g Al/ha reduced colonies by 81.1% in 10 months. The present paper presents the results of a large-scale field test of the efficacy this compound in central Texas against S. invicta and the effect this compound has on nontarget ant species of the area.
MATERIALS AND METHODS

Large-scale field testing on ca. 200,000 ha with Pro-Drone was conducted at non-adjacent sites in Kendall and Kerr Cos., Texas. A standardized bait formulation (Stauffer Chemical Co., Westport, CN) was aerially broadcast at a rate of 11.86 g Al/ha between 10-20 June 1983 and again between 26 September - 1 October 1983. Two study sites for each of four habitat types were used as test and control areas. Habitat types selected were juniper-grassland, live oak-grassland, grazed pasture-grassland, and southern cypress-grassland communities.

A line transect of 20 pitfall traps (440 ml plastic cups containing ethylene glycol placed ca. 5 m apart) was established in each site (design based on recommendations of D. Wojcik, pers. comm. 1983). An asphalt roofing shingle was placed over each trap to form a protective cover. Traps were placed in the field for 7 day periods each 3 wks from May 1983 to April 1984. All ants trapped were identified and counted. Several species were detected only infrequently and were not encountered in both treated and control areas. Therefore, these species could not be compared between treatments and were not included in the analyses. Identifications were verified against determined specimens in the Texas Tech University Museum. Several specimens could be identified only to genus. Voucher specimens have been preserved and deposited in that museum.

A total of 1,920 samples (20 traps/site: 8 sites) was collected during 12 sampling periods. The study was treated as a randomized complete block design with two treatments blocked according to the four habitat types (i.e. there were four replications). All experimental units (E.U. = species) were subjected to a set of standardized conditions and treated alike (Gill 1978). Therefore, the mean number of species or individuals within a species occurring each month within each of the four habitats (blocks) was plotted through time for both the treated and control areas. Analysis of covariance was performed to test the homogeneity of regression coefficients. Data were then analyzed using simple regression and Student’s t-test for homogeneity of regression slopes. Also, the mean number of species occurring each month for the first six months in the treated and untreated areas was compared by Student’s paired t-test, as was the mean number occurring the last six months. A comparison of species richness between treatments for the first six months and again for

![Graph](image)

TABLE 2. Probability that Linear Regression Slopes are Significantly Different for the No. of Species and the No. of Individuals/Species in the Pro-Drone Treated and Control Areas of Bandera, Kendall, and Kerr Cos., Texas (May 1983 - April 1984).

<table>
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<th>Category</th>
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<tbody>
<tr>
<td>Habitat (species richness)</td>
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<tr>
<td>Southern cypress-grassland</td>
<td>0.956 ns</td>
</tr>
<tr>
<td>Live oak grassland</td>
<td>1.500 ns</td>
</tr>
<tr>
<td>Juniper-grassland</td>
<td>1.129 ns</td>
</tr>
<tr>
<td>Pasture-grassland</td>
<td>1.022 ns</td>
</tr>
<tr>
<td>Subfamily (no. of species)b</td>
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<tr>
<td>Dolichoderinae</td>
<td>0.497 ns</td>
</tr>
<tr>
<td>Formicinae</td>
<td>0.613 ns</td>
</tr>
<tr>
<td>Myrmicinae</td>
<td>0.633 ns</td>
</tr>
<tr>
<td>Species (no. of individuals)</td>
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<tr>
<td><em>Solenopsis invicta</em> Buren</td>
<td>1.166 ns</td>
</tr>
<tr>
<td><em>Pheidole sp.</em></td>
<td>2.110*</td>
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<td><em>Monomorium minimum</em> (Buckley)</td>
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<td><em>Paratrechina terricola</em> (Buckley)</td>
<td>0.100 ns</td>
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<td>0.920 ns</td>
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aStudent’s t-test; P<0.05, d.f. = 20, critical t = 2.086; ns = not significant; * = significantly different, but regression slope of the control is more negative than that of the treated.
bOnly subfamilies represented by at least five species were regressed through time.

the last six months allowed sufficient replication of samples over time and minimized variation resulting from phenological fluctuations (Samways 1983).

RESULTS

Twenty-four taxa representing five subfamilies (Dolichoderinae, Ectoninae, Formicinae, Myrmicinae, and Ponerinae) were trapped in this study (Table 1). Each taxon included in the analyses from the eight study sites occurred in at least one community from both the test and control areas. Based on frequency of capture, *S. invicta* appeared to be the dominant species and was trapped 71 times. The most frequently trapped non-target ants were *Pheidole sp.*, *Monomorium minimum* (Buckley), *Paratrechina terricola* (Buckley), *Pachycondyla harpax* (F.), and *Forelius pruinosus* (Roger).

Analysis of covariance indicated that the variance in species richness among habitats (blocks) was the same at each sampling point in time (months). Therefore, according to Gill (1978), the covariance for any two sampling points would be homogeneous. Because of this homogeneity of variance among blocks, the mean number of ant species occurring in each community for the test and control could be regressed through time (Fig. 1). Regression indicates that the relationship between species richness and time in both test and control areas is linear (P<0.01). In addition, the high coefficients of determination (control: $r^2 = 0.86$;

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\[ t = 1.07 \text{ ns} \]  
\[ t = 2.04 \text{ ns} \]

\( ^a \)Student's paired t-test (\( P > 0.05 \), d.f. = 10, critical \( t = 2.28 \)).  
\( ^b \)ns = not significant.

treated: \( r^2 = 0.94 \) indicate that the linear model describes the data well for both treatments. A test for homogeneity of regression slopes between treated and control indicated no significant difference (\( t = 0.059 \); d.f. = 20; \( P > 0.05 \)). Therefore, species richness through time in the treated area was no different from that in the control area. Also, no significant differences were detected in species richness of the habitats, in the number of species per subfamily, or in the number of individuals per species (including \( S. \) invicta) between the two treatments through time (Table 2).

No significant difference was detected in species richness between treated and control plots during the first six months after treatment application (Table 3). Additionally, no significant difference was detected between treatment means for the last six months.

DISCUSSION

Various researchers have utilized pitfall traps to study foraging behavior of fire ants and community structure of other ants (Apperson and Powell 1984, Samways 1983). Although various problems are associated with interpretation of results from sampling by this technique, the method does provide reliable information and allows for comparison among communities regarding annual periodicity of activity and species composition (Adis 1979). To maximize the number of ground foraging ant species trapped in our study, four distinct communities were chosen in each locality. Species richness of the two localities was essentially the same, indicating that the two treatments were homogeneous.

The number of species collected pretreatment in the treated areas was less than in the control areas and this tendency continued in post-treatment samples. The largest numbers (species and individuals/species) were detected at the beginning of the study, indicating that the greatest foraging activity occurred in May and June. The continual decline in numbers may have resulted from the effect of cooler temperatures with the onset of winter and the unusually dry spring experienced during the test period. However, because neither the number of individuals within each species nor species richness for each habitat was significantly lower in the treated area than in the control area, Pro-Drone had no
apparent effect on the ant fauna (target and nontarget species) in Kendall and Kerr Cos., Texas.

The apparent failure of this insect growth regulator to reduce the number of foraging S. invicta in the present study is difficult to explain, whereas the lack of effect on nontarget ants might have been expected since the bait is specifically formulated for S. invicta. Also, a study conducted in southeastern Texas indicated that S. invicta forages quickly and efficiently on Pro-Drone bait (Phillips and Thorvilson 1986). However previous field and laboratory studies on the action of Pro-Drone on S. invicta (Banks and Schwarz 1980, Banks et al. 1983) showed considerable efficacy (64-80% colony death). In addition, Phillips et al. (1985) reported that Pro-Drone significantly reduced S. invicta infestations (81.1%) and completely eliminated worker brood. The present study was conducted over a much larger area than previous studies (200,000 ha) and the application rate (11.86 g AI/ha) was the same as that which provided the best control. Because our study lasted for one year, ample time was permitted for the IGR to affect S. invicta. Although pitfall trapping of worker ants probably is not as good an indicator of S. invicta colony viability as individual colony inspection, reports from land owners in the treated areas and from USDA researchers (H. Collins, unpublished) confirm the lack of significant effect of the IGR on S. invicta mound activity. Weather conditions possibly altered the effectiveness of this IGR, but such effects do not seem likely as the IGR was applied over several days during two different seasons. The predominance of polygynous S. invicta colonies in our test area, which were absent in previous trials, suggest further study of the effects of IGRs on polygynous colonies is needed to determine if these colonies are less affected by IGR treatments than are monogynous colonies.

ACKNOWLEDGMENT

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