Impact of *Solenopsis invicta* Buren Suppression on Arthropod Ground Predators and Pest Species in Soybean[1]

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Abstract The red imported fire ant, *Solenopsis invicta* Buren, reportedly contributes to the biological control of key soybean pests. However, *S. invicta* may negatively affect ground-dwelling natural enemies such as ground beetles and earwigs. Information on the interactions between natural enemies is important for anticipating the success of biological control in agroecosystems with multiple interacting entomophagous species. Ground arthropods were monitored in soybean using pitfall traps in the 2000 and 2001 growing seasons to determine their response to selected fire ant controls. Three treatments were examined: an untreated check, Amdro™ (hydramethylnon) bait (ant-specific), and Lorsban™ (chlorpyriphos) (broad spectrum) plus Amdro. Fire ant captures in pitfall traps were lower in the Amdro and in the Amdro plus Lorsban treatments compared to the untreated control. Reduced fire ant density plus chemical treatment impacted the abundance of certain ground predators. Spiders, primarily Lycosidae, were significantly more abundant in the untreated control plots on some sampling dates; whereas, the earwig *Labidura riparia* Pallas was more abundant in the Lorsban and Amdro plots, presumably due to the removal of fire ants and other natural enemies. Ground beetles (Carabidae) were not different between treatments on any sampling dates. This study supports the assumption that spiders are compatible with fire ants as natural enemies and that earwigs are not compatible with fire ants. Numbers of lesser cornstalk borer, *Elasmopalpus lignosellus* Zeller, were not affected by the suppression of fire ant predation or the chemical treatments in 2000, the only year when they were captured. Crickets (Gryllidae), mole crickets (Gryllotalpidae), click beetles (Elateridae), scarab beetles (Scarabaeidae), and false darkling beetles (Melandryidae) also were not different between the fire ant suppression treatments.

Key Words Red imported fire ant, *Solenopsis invicta, Glycine max, Labidura riparia,* arthropod ground predators, natural enemy interactions

The red imported fire ant, *Solenopsis invicta* Buren, is considered a pest due to medical hazards it presents to people and livestock and the damage it inflicts on structures, harvesting equipment and the native fauna (Taber 2000, Lofgren 1986). However, *S. invicta* have been reported to be beneficial in some agroecosystems. Predation by *S. invicta* on the boll weevil, *Anthonomus grandis grandis* Boheman, in cotton can reduce or prevent economic damage from this pest in east Texas (Sterling et al. 1984, Sterling 1978). *Solenopsis invicta* infestations have also been reported to lower peanut damage caused by lepidopteran larvae (Vogt et al. 2001). Fire ants have

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been observed attacking all stages of the sugarcane borer, *Diatraea saccharalis* F. (Negm and Hensley 1969). When sugarcane was treated with Mirex™ (dechlorane) (Hooker Chemical Company, Niagara Falls, NY manufactured the product from 1957 to 1976) to suppress fire ants, borer infestation levels increased by 53% and damage increased by 69%. These changes were attributed to the decrease in *S. invicta* numbers in treated plots (Reagan et al. 1972). However, other experiments have indicated that native ants are more important in sugarcane borer suppression (Adams et al. 1981).

Sterling et al. (1979) reported that *S. invicta* even at high densities, did not negatively impact natural enemies in cotton, and Vogt et al. (2002) reported similar results in peanut. However, it has been widely reported that *S. invicta* preys on natural enemies of crop pests or reduces their effectiveness by disturbing them (Lopez 1982, Vinson and Scarborough 1989, 1991, Tedders et al. 1990). Eubanks (2001) reviewed the direct and indirect effects of *S. invicta* as biological control agents. Although numerous reports are published on *S. invicta* predation, additional studies are needed to clarify the intraguild interactions of fire ants with other entomophages.

Soybean fields in the southern United States are often heavily infested with *S. invicta,* with 22.2 to 207.5 active mounds per ha (Banks et al. 1990). The number of active mounds is reduced with conventional tillage (Morrill and Greene 1975), and with the increasing adoption of conservation tillage, abundance of fire ants could increase in fields. Kidd and Apperson (1984) concluded that fire ants forage mainly on the soil surface and rarely forage higher than 20 cm on soybean plants. Despite this, *S. invicta* is reportedly an important predator of foliage-inhabiting soybean pests such as southern green stink bugs, *Nezara viridula* (L.), and the velvetbean caterpillar, *Anticarsia gemmatalis* Hübner (Krispyn and Todd 1982, Stam et al. 1987, Elvin et al. 1983).

The ground arthropod predator complex in soybeans consists mainly of earwigs, ground beetles, tiger beetles, along with ants usually dominated by *S. invicta* in the southern region of the United States. Predation by this complex is the main biotic mortality source for pupae of the velvetbean caterpillar in Louisiana soybeans (Lee et al. 1990). *Solenopsis invicta* was the main predator in this assemblage, accounting for 77.5 to 96.5% of all predation on velvetbean caterpillar pupae. Decreased numbers of ground predators, namely fire ants, in heptachlor-treated soybeans led to higher numbers of velvetbean caterpillar and green cloverworm, *Hypena scabra* (F.), larvae (Brown and Goyer 1982). The scientific literature suggests that, while fire ants are important natural enemies of pests, they also may interfere with other ground predators. Brown and Goyer (1982) noted that fire ants were observed preying on carabid larvae and that there were significantly more ground beetles in plots where fire ants were suppressed. Lee et al. (1990) observed higher numbers of the carabid beetles *Calosoma alternans sayi* Dejean and *Pterostichus chalcites* Say, and the striped earwig, *Labidura riparia* Pallas, in plots where fire ants were suppressed. Similarly, Gross and Spink (1969) reported higher numbers of *L. riparia* in yards and fields that had been treated with heptachlor and mirex, both of which are highly toxic to fire ants.

The objective of the present investigation was to determine the impact of fire ant suppression on other predatory ground arthropods in soybeans by monitoring their relative abundance with pitfall traps after the application of select fire ant suppression treatments. Although pitfall trap catches are influenced by habitat and cannot be used to measure absolute density, they are commonly used to gather information about composition and abundance of epigeic predaceous arthropods (Kharboutli and Mack

1991, Wiedenmann et al. 1992). They can also be used to obtain comparative information among treatments.

Materials and Methods

Tests were conducted at the Coastal Plain Experiment Station in Tift Co., GA in 2000 and 2001. Two test locations were utilized, the Bradford Research Farm located 8 km north of the Experiment Station campus and the Shannon Research Farm located 11 km east of the campus. These sites were selected because conservation tillage was practiced at both sites and no specific attempts to reduce fire ant densities had been made at either location. Thus, these research sites were naturally infested with *S. invicta* at levels representative of crop fields in the coastal plain.

Soybeans (Deltapine 6200 RR) were planted into wheat stubble with a no-till drill planter with 17.8 cm row spacing at the Bradford test site on 7 June 2000. At the Shannon test site, soybeans (Northrup King 73Z5 RR) were planted on 14 June 2000 in 1.8 m beds with 0.91 m row spacing with a strip-till planter into rye stubble. Glyphosate (Roundup Ultra, Monsanto Corp, St. Louis, MO) was applied at 2.3 L per ha at both locations for weed control approximately 2 wks after planting. Soybeans were planted on the same two research locations in 2001 (Shannon on 4 June 2001 and Bradford on 11 June 2001) with identical cultural practices, except the Shannon research site was planted into a fallow field after herbicide burndown instead of into rye stubble, as the year before.

The test sites were partitioned into plots that averaged 0.3 ha each, and the plots were assigned to one of three treatments: (1) an untreated control, (2) Amdro™ (hydramethylnon) (BASF Corp., Mt. Olive, NJ) bait broadcast at 1.7 kg/ha, or (3) broadcast applications of Lorsban™ (chlorpyriphos) (Dow AgroSciences, Indianapolis, IN) at 2.33 L/ha + Amdro (1.7 kg/ha). Amdro was applied with a hand spreader over the entire Amdro-treated plot; however, a 4.5 m untreated border was left on all 4 edges to minimize overlap of treatment effects on foraging ant populations. Lorsban was broadcast over the entire designated area of the Lorsban-treated plots using a tractor-mounted sprayer. Treatments were arranged into a randomized block design with three replications at each farm in 2000 and four replications in 2001.

In 2000, Amdro was applied to designated plots at both sites 5 d after planting and again in early July when fire ants were detected at low numbers in the treated plots. Lorsban was applied to designated plots 2 d after the Amdro applications. In 2001, initial treatments of Amdro and Lorsban were made shortly after planting. Both test sites were re-treated with Amdro on 20 July and Lorsban on 23 July to insure fire ant suppression in the treated plots.

Ground arthropods were monitored in the experimental plots using pitfall traps. Traps were constructed by placing a 500-mL plastic cup into the ground into which an identical container was placed so that its lip was flush with the ground. A 300 mL mixture of ethylene glycol (2/3) water (1/3) was added to the inner cup to kill and preserve the captured specimens. A 15 × 15 cm piece of roofing shingle supported approximately 2.5 cm above the soil surface with nails on the 4 corners, provided a barrier to flooding and debris. Two traps were randomly placed in the interior of each plot at least 15 m from the borders. Traps remained in the field for 7 days, then the inner cup was removed, capped, labeled and returned to the lab where arthropods were identified and counted. In 2000, three samples were taken from each farm between late July and late August (specific dates in Table 2). In 2001, four samples were taken between late June and late August (Table 2). Insect counts for each group, each date and for the overall season were analyzed with ANOVA using GLM procedure (SAS Institute 1990). Treatment means were separated using Tukey's studentized range test. Specimens of the insects reported in this study are deposited in the arthropod collection at the Georgia Natural History Museum, The University of Georgia (Athens).

Results

Fire ants. The seasonal mean number of *S. invicta* individuals captured in pitfall traps differed significantly among treatments for both years (Table 1, for 2000 $F = 9.89$; df = 2, 38; $P = 0.0003$; for 2001 $F = 23.40$; df = 2, 75; $P < 0.0001$), with more ants trapped in the untreated plots than the treated plots. In both years, the highest mean number of fire ants caught in the pitfall traps occurred in the untreated plots on every sampling date (Table 2). In 2000, treatment effects differed on all sampling dates (Table 2), with more fire ants captured in the untreated plots than in the Amdro or Lorsban + Amdro plots, the only exception being the week ending 20 August when the untreated and Lorsban + Amdro were not different. In 2001, significantly more fire

Table 1. Seasonal means (±standard errors) of ground arthropod predators captured per pitfall trap in three different fire ant suppression treatments applied in soybean, Tift Co. Georgia, 2000 and 2001

Predator Sampled	Untreated	Amdro 1.7 kg/ha	Lorsban 2.3 L/ha + Amdro 1.7 kg/ha	F	P	df
2000						
Fire Ants	33.2 ± 8.8 a	2.6 ± 0.6 b	5.5 ± 2.1 b	9.89	0.0003	2,38
Spiders	5.8 ± 0.6 a	3.5 ± 0.5 b	2.2 ± 0.4 b	11.94	0.0001	2,38
Predatory Beetles*	3.0 ± 0.9 a	3.3 ± 0.5 a	2.9 ± 0.9 a	0.13	0.8752	2,38
Earwigs**	5.0 ± 1.4 b	9.5 ± 3.1 ab	15.2 ± 3.9 a	7.17	0.0023	2,38
2001						
Fire Ants	19.5 ± 3.4 a	3.6 ± 0.7 b	3.6 ± 1.1 b	23.40	0.0001	2,75
Spiders	3.1 ± 0.5 a	2.7 ± 0.5 a	1.8 ± 0.3 b	4.51	0.0142	2,75
Predatory Beetles*	5.0 ± 1.4 a	4.4 ± 0.9 a	2.9 ± 0.7 a	1.71	0.1879	2,75
Earwigs**	3.2 ± 1.1 b	11.6 ± 4.1 ab	17.2 ± 3.0 a	6.55	0.0024	2,75

Treatment means within rows followed by the same letter are not significantly different ($P > 0.05$, Tukey's studentized range test). Means from 3 collections dates in 2000 and 4 collection dates in 2001.

* Mostly Carabidae but includes some Ciccindellidae and Staphylinidae.

** Almost entirely *Labidura riparia* Pallas, the striped earwig, with occasional individuals of Carcinophoridae.

Table 2. Mean number (±standard errors) of fire ants captured per pitfall trap in three different fire ant suppression treatments applied in soybean, Tift Co. Georgia 2000 and 2001

Sampling* Date	Untreated	Amdro 1.7 kg/ha	Lorsban 2.3 L/ha + Amdro 1.7 kg/ha	F	P	df
2000						
24 July	22.7 ± 2.6 a	3.3 ± 1.4 b	7.4 ± 4.2 b	17.27	0.001	2,8
8 Aug	26.2 ± 13.1 a	2.3 ± 1.1 b	0.1 ± 0.1 b	4.92	0.040	2,8
20 Aug	51.5 ± 22.5 a	1.3 ± 0.6 b	9.0 ± 4.5 ab	5.98	0.026	2,8
2001						
26 June	20.6 ± 7.1 a	6.1 ± 2.0 a	8.9 ± 3.6 a	3.65	0.057	2,12
16 July	28.1 ± 7.8 a	4.7 ± 1.5 b	4.7 ± 1.4 b	7.69	0.007	2,12
7 Aug	21.6 ± 7.8 a	2.2 ± 0.7 b	0.2 ± 0.2 b	7.53	0.008	2,12
22 Aug	7.6 ± 1.7 a	1.4 ± 0.8 b	0.6 ± 0.3 b	16.49	0.0004	2,12

Treatment means within rows followed by the same letter are not significantly different ($P > 0.05$, Tukey's studentized range test).

* Dates indicate when traps were retrieved; traps were placed in field one week prior to retrieval.

ants were captured in the untreated plots than either of the treated plots on all sampling dates except on the week ending 26 June (Table 2), and even then there was a trend ($P = 0.057$) for more ants in the untreated plots. A large amount of variation existed in the number of ants captured in the untreated plots in late August. On the 20 August collection date in 2000, the highest number of fire ants were captured; whereas, on 22 August 2001, the lowest number of ants were captured. Low temperature reportedly affects fire ant capture in pitfall traps (Porter and Tschinkel 1987). In our study, temperatures never dropped below 17°C; however, the daily high temperatures exceeded 32°C at our study sites in both 2000 and 2001, and high temperatures also have been reported to affect foraging of *S. invicta* (Porter and Tschinkel 1987, Vogt et al. 2003).

Spiders. In 2000, significantly more spiders were captured in the untreated plots in comparison to the plots treated with ant-suppression insecticides ($F = 11.94$; df = 2; 38, $P < 0.0001$, Table 1). Treatment differences were apparent on the first two sampling dates in 2000 (Table 3); however, on the last date (20 August) no differences between treatments were detected. In 2001, numbers of spiders captured did not differ among treatments on any sampling date (Table 3). However, on most dates there tended to be a lower mean spider capture ($P = 0.06$ to 0.07) in the Lorsban + Amdro treatment than the untreated and Amdro plots. When the spider catch was analyzed over all of the 2001 sampling dates, the Lorsban + Amdro treatment was significantly lower than the other two treatments ($F = 4.51$; df = 2, 75; $P = 0.0142$). Spider populations appeared to remain relatively constant throughout both seasons. Although no species records were maintained in this study, most of the spiders collected in our pitfall traps were members of the Family Lycosidae.

Table 3. Mean number (±standard errors) of spiders captured per pitfall trap in three different fire ant suppression treatments applied in soybean, Tift Co. Georgia, 2000 and 2001

Sampling* Date	Untreated	Amdro 1.7 kg/ha	Lorsban 2.3 L/ha + Amdro 1.7 kg/ha	F	P	df
2000						
24 July	5.3 ± 1.0 a	3.0 ± 1.2 b	2.7 ± 1.0 b	8.27	0.0113	2,8
7 Aug	7.1 ± 1.2 a	3.0 ± 0.5 b	1.2 ± 0.4 b	17.69	0.0012	2,8
20 Aug	4.9 ± 1.1 a	4.7 ± 0.9 a	2.7 ± 0.8 a	1.58	0.2647	2,8
2001						
26 June	4.4 ± 1.7 a	4.9 ± 1.5 a	2.6 ± 0.9 a	3.23	0.0757	2,12
16 July	3.5 ± 0.7 a	3.7 ± 0.6 a	2.4 ± 0.7 a	1.09	0.3676	2,12
7 Aug	1.9 ± 0.4 a	1.7 ± 0.5 a	0.7 ± 0.2 a	3.45	0.0656	2,12
22 Aug	2.6 ± 0.6 a	1.8 ± 0.3 a	1.4 ± 0.3 a	3.26	0.0738	2,12

Treatment means within rows followed by the same letter are not significantly different ($P > 0.05$, Tukey's studentized range test).

* Dates indicate when traps were retrieved; traps were placed in field one week prior to retrieval.

Predaceous beetles. This group consisted almost entirely of ground beetles (Carabidae), but included an occasional tiger beetle (Cicindellidae) and rove beetle (Staphylinidae). No differences in seasonal mean pitfall capture of predaceous beetles were detected between treatments (Table 1) (for 2000, $F = 0.13$; df = 2,38; $P = 0.8752$; for 2001, $F = 1.71$; df = 2,75; $P = 0.1879$), nor were any differences among treatments found on any individual sampling date on either year.

Earwigs. Although a few carcinophorids were occasionally captured, the most abundant earwig captured at our study sites was *Labidura riparia* Pallas, the striped earwig. In 2000, significantly more earwigs were captured in the Lorsban + Amdro treatment than in the untreated plots (Table 1) ($F = 7.17$; df = 2,38; $P = 0.0023$). This same relationship between earwig capture and treatments was seen on all sampling dates in 2000, but was significant only on 20 August (Table 4). In 2001, a similar overall pattern was seen with earwig capture, as the number captured in the Lorsban + Amdro treatment was significantly greater than the number captured in the untreated plots (Table 1) ($F = 6.55$; df = 2, 75; $P = 0.0024$). This difference between treatments was apparent on three of the four individual sampling dates as well (Table 4).

In 2001 there were significantly more earwigs at the Bradford test site than the Shannon test site ($F = 32.03$; df = 1,75; $P < 0.0001$). As previously mentioned, there was a difference in cultural practices between these two farm sites. At the Bradford site, soybeans followed a wheat crop and at the Shannon site, soybeans followed herbicide treatment in a fallow field. Table 5 presents the means for earwigs caught per trap on each sampling date at the two study sites in 2001. Very few earwigs were

Table 4. Mean number (±standard errors) of earwigs captured per pitfall trap in three different fire ant suppression treatments applied in soybean, Tift Co. Georgia, 2000 and 2001

Sampling* date	Untreated	Amdro 1.7 kg/ha	Lorsban 2.3 L/ha + Amdro 1.7 k/ha	F	P	df
2000						
24 July	2.9 ± 1.9 a	7.7 ± 6.7 a	7.7 ± 5.3 a	1.14	0.3669	2,8
8 Aug	4.6 ± 1.7 a	7.7 ± 4.1 a	10.3 ± 4.0 a	3.10	0.1007	2,8
20 Aug	7.6 ± 3.6 b	13.2 ± 6.0 ab	27.6 ± 8.1 a	5.32	0.0339	2,8
2001						
26 June	0.9 ± 0.6 a	0.6 ± 0.2 a	0.4 ± 0.2 a	0.51	0.6149	2,12
16 July	1.9 ± 0.6 b	7.6 ± 3.4 ab	10.4 ± 3.4 a	5.64	0.0187	2,12
7 Aug	1.9 ± 1.0 b	9.6 ± 3.7 ab	15.3 ± 5.4 a	10.65	0.0022	2,12
22 Aug	8.2 ± 3.8 b	28.7 ± 14.5 ab	42.7 ± 15.7 a	6.35	0.0132	2,12

Treatment means for each date followed by the same letter are not significantly different ($P > 0.05$, Tukey's studentized range test).

* Date represents day trap was removed; traps were placed in field one week prior to removal.

present throughout 2001 at the Shannon site (ranged from 0 to 4.1 per trap); however, the difference between the Lorsban + Amdro treatment and the untreated plots was statistically significant on 22 August. At the Bradford site, where earwigs were much more abundant, a treatment effect was significant on the three later sampling dates. When earwig capture is combined for all dates at the Bradford site, the Amdro alone and Lorsban + Amdro treatments had significantly more earwigs than the control (Table 5). At both test locations, earwig abundance tended to increase throughout the season with the lowest numbers being captured on the first sampling date and the highest on the later sampling dates.

Arthropod pests. Lesser cornstalk borer, *Elasmopalpus lignosellus* Zeller (Lepidoptera: Pyralidae), larvae were captured in pitfall traps in 2000, but not in 2001. This coincides with lesser cornstalk borer problems that were occurring in Tift Co. during the dry conditions of 2000 (0.07 and 7.6 cm of precipitation in May and June, respectively) reported at the state climatological station at Tifton; whereas, the 2001 season had more rainfall (3.8 cm in May and 17.7 cm in June) and no borer infestations. Most borers were captured on the first sampling date of 24 July 2000 (4.7 to 7.7 borers per trap), and there was characteristic borer damage (plants breaking at soil surface and wilting) at that time. No treatment differences were detected on 24 July ($F = 0.507$; df = 2, 8; $P = 0.9358$) when numbers were highest or at any other time in the 2000 season. Over all three dates combined in 2000, there were also no treatment differences in borer numbers ($F = 0.05$; df = 2,38; $P = 0.95$).

Crickets (Orthoptera: Gryllidae) were abundant at both sites and both years, but no differences were detected among treatments on any sampling date or over all dates.

Table 5. Comparison of earwigs captured per pitfall trap (±standard error) in three different fire ant suppression treatments at two test sites in Tift County Georgia, 2001

Date and test site	Untreated	Amdro 1.7 kg/ha	Lorsban 2.3 L/ha + Amdro 1.7 kg/ha	F	P	df
26 June*						
Bradford	1.9 ± 1.1 a	1.1 ± 0.2 a	0.9 ± 0.1 a	0.51	0.6939	2,6
Shannon	0.0 ± 0.0 a	0.0 ± 0.0 a	0.0 ± 0.0 a	—	—	2,6
16 July						
Bradford	2.1 ± 0.4 b	14.2 ± 4.9 ab	18.7 ± 2.3 a	5.74	0.0404	2,6
Shannon	1.7 ± 1.2 a	1.0 ± 0.4 a	2.1 ± 1.5 a	0.80	0.4930	2,6
7 August						
Bradford	1.6 ± 0.7 b	15.1 ± 6.0 ab	27.1 ± 3.4 a	9.67	0.0133	2,6
Shannon	2.1 ± 2.1 a	4.1 ± 3.0 a	3.6 ± 2.7 a	4.22	0.0718	2,6
22 August						
Bradford	16.0 ± 5.3 b	55.6 ± 22.3 ab	81.7 ± 11.7 a	5.79	0.0397	2,6
Shannon	0.5 ± 0.2 b	1.7 ± 0.9 ab	3.7 ± 1.4 a	5.09	0.0510	2,6
Dates combined						
Bradford	5.4 ± 2.0 b	21.5 ± 7.5 a	32.1 ± 8.3 a	12.62	<.0001	2,33
Shannon	1.1 ± 0.6 a	1.7 ± 0.8 a	2.3 ± 0.8 a	0.92	0.4096	2,33

Treatment means for each date followed by the same letter are not significantly different ($P > 0.05$, Tukey's studentized range test). Bradford farm no-till planted into wheat residue. Shannon farm strip-till planted into fallow field after herbicide burndown.

* Dates indicate when traps were retrieved; traps were placed in field one week prior to retrieval.

Mole crickets (Orthoptera: Gryllotalpidae) were not abundant during this study, and only 8 total were captured. On two occasions, fire ants were observed foraging on a dead mole cricket at our study sites (pers. obs.). Click beetle adults (Coleoptera: Elateridae), scarab beetle adults (Coleoptera: Scarabaeidae), and false darkling beetle adults (Coleoptera: Melandryidae) were often captured in our pitfall traps but no differences were seen between treatments or dates for any of these species.

Discussion

Morrison (2002) reported that *S. invicta* was the most abundant ant species in Texas in 1999, although not nearly as abundant as when it initially invaded the area in the late 1980's. Thus, it is suggested that the impact of such invasive ants may be greatest during and soon after the initial phase of an invasion (Morrison 2002). Fire ants have been present in Georgia for many years and have been found in all 159 countries since 1997 (Sparks et al. 2003). They impact many agricultural production systems plus inhabit areas near dwellings where human contact is frequent. Over $61 million in control costs and damage were reported for fire ants in Georgia in 2000 (Sparks et al. 2003)

Insecticide treatments to suppress fire ants did elicit a change in the composition of the ground predator assemblage. Fire ants were suppressed in both the Amdro and Amdro + Lorsban treatments relative to the untreated check. In both years, the highest numbers of spiders were captured in untreated plots. It appears that spider abundance is not negatively impacted by fire ant presence and, at times, spiders are more numerous in areas of high fire ant density. Similar results have been reported in peanut (Vogt et al. 2002). This suggests that spiders and fire ants may be compatible as natural enemies in soybean and other crops. Wolf spiders (Family Lycosidae) were the most abundant spiders collected in our study. This is not surprising because pitfalls are most effective in capturing actively moving ground-dwelling spiders (Whitcomb 1980). Ferguson et al. (1984) reported that Lycosidae were the most prevalent spiders in their pitfall traps in soybeans; however, other families were also present in low numbers. In our study, we saw no difference in carabid beetle numbers between treatments, although Brown and Goyer (1982) and Lee et al. (1990) observed higher populations of ground beetles in plots where fire ants were suppressed. When earwigs were abundant, higher numbers were found in the plots treated with Lorsban and Amdro bait in comparison to the untreated areas. This is likely due to a decrease in earwig natural enemies in the treated plots of which fire ants seem important. This agrees with the results reported by Gross and Spink (1969) that earwigs were more abundant in areas that had been treated to suppress fire ants. Additionally, cultural practices (presence or absence of cover crop proceeding soybean) may have impacted earwig numbers in our study, although these observations are limited. Notably, very few earwigs were captured in our sampling in soybeans planted into a field that had no cover crop or wheat double crop. The importance of earwigs in biological control of agricultural pests has not been well quantified, but we conclude that earwigs and *S. invicta* are not compatible because earwig numbers are inversely related to the number of fire ants.

The change in the ground predator assemblage due to insecticidal suppression of fire ants did not impact populations of lesser cornstalk borer in 2000, the only year with sufficient numbers to evaluate. Additionally, foliar pests such as caterpillars and stink bugs captured in 25-sweep samples were not affected by the insecticide treatments and the subsequent changes in the ground predator complex (Seagraves, unpubl. data). Although *S. invicta* negatively impacts some natural enemies (i.e., earwigs), fire ants appear to be compatible and, at times, were positively associated with higher numbers of ground-dwelling spiders.

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