Nontarget Effects of Soil-Applied Chlorpyrifos on Defoliating Pests and Arthropod Predators in Peanut[1]

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ABSTRACT

Studies determined the effects of granular chlorpyrifos on densities of nontarget arthropods in peanuts. A portion of several commercial fields was treated during the early pod stage of peanut growth in 1987 and 1988; then, densities of defoliating pests and arthropod predators were estimated weekly. Populations of *Helicoverpa* spp. were significantly increased in 1987 by chlorpyrifos application, but were not significantly affected in 1988. Densities of the velvetbean caterpillar, *Anticarsia gemmatalis* Hubner, were low on most sample dates. On dates when densities were great, populations were directly suppressed by chlorpyrifos application. Densities of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), were always low, and were not affected by chlorpyrifos application. Arthropod predators sampled included the red imported fire ant, *Solenopsis invicta* Buren; spiders (Aranaea: Araneidae); ground beetles (Coleoptera: Carabidae); earwigs (Dermaptera: Labiduridae); damsel bugs (Hemiptera: Nabidae); and bigeyed bugs (Hemiptera: Lygaeidae). Densities of spiders were significantly decreased by chlorpyrifos application. The other predators were not significantly affected. These results demonstrate that chlorpyrifos application results in nontarget effects on defoliating pest populations. Treated fields should be scouted regularly, because such fields may have an increased potential for outbreaks of some defoliating pests.

Key Words: Insecta *Arachis hypogaea* L., *Helicoverpa* spp., *Spodoptera frugiperda* (J. E. Smith), *Anticarsia gemmatalis* Hubner, chlorpyrifos

Soil insect pests, primarily lesser cornstalk borer (*Elasmopalpus lignosellus* Zeller) and southern corn root worm (*Diabrotica undecimpunctata howardi* Barber), are key insect pests of peanut in the southeastern U.S. (7). Infestations that occur anytime between beginning pod and maturity [i.e, the R3 to R8 peanut growth stages (2)] can result in serious economic losses (6). Chlorpyrifos is efficacious against the soil-insect pest complex and is the most commonly used soil insecticide in peanut. Under normal growing conditions, chlorpyrifos applied during the R3 stage of peanut growth will provide residual efficacy until the R8 stage of peanut growth (5).

Soil-insect pests are effectively managed when insecticides such as chlorpyrifos are applied before populations reach outbreak levels. Because soil insecticides require rainfall or irrigation to be effective, control frequently does not occur rapidly enough to prevent unacceptable economic losses when applications are made after populations reach outbreak densities (1). Consequently, peanut producers sometimes apply chlorpyrifos as a preventative management practice.

Peanut fields in the southeastern U.S. are inhabited by a guild of leaf feeding species. Important species include the bollworm, *Helicoverpa zea* (Boddie); the tobacco budworm, *H. virescens* (Fabricius); the velvetbean caterpillar, *Anticarsia gemmatalis* Hubner; and the fall armyworm, *Spodoptera frugiperda* (J. E. Smith). Peanut fields also are inhabited by a guild of arthropod predators, including the red imported fire ant (*Solenopsis invicta* Buren), bigeyed bugs, damsel bugs, ground beetles, earwigs, and spiders. Many of these predatory species are important biological control agents of insect pests, preventing or ameliorating the severity of outbreaks.

The objective of this study was to determine the effects of soil-applied chlorpyrifos in peanut on densities of *Helicoverpa* spp., velvetbean caterpillar, and fall armyworm. The effects on densities of common predators in peanut fields also were evaluated.

Materials and Methods

Experiments were conducted in conventionally tilled and planted peanut fields at a 91-cm row spacing located in Jackson Co. in Florida. Experimental design was a randomized complete block with four fields in 1987 and two fields in 1988 serving as blocks. Row spacing in all fields was 91 cm. Peanut varieties each year were Florunner and NC 7. Standard agronomic practices were used for weed and disease control. Treatments consisted of an untreated control and an application of granular chlorpyrifos (Lorsban 15G, Dow Chemical Co., Midland, Mich. 48641) at the rate of 2.24 kg (AI)/ha in a 30 to 35 cm band over the row. Chlopyrifos was applied during the early pod fill stage of peanut growth (2) with a tractor-mounted granular applicator (Gandy Co., Owatonna, MN 55060) on 27 July in 1987 and on 6 or 7 July in 1988. A 2-ha treated and untreated area within each field was sampled, beginning soon after chlorpyrifos application and ending at about harvest. No other insecticide applications were made in the fields.

Densities of larval velvetbean caterpillars, fall armyworms, and *Helicoverpa* spp. and adult and immature spiders, damsel bugs, and bigeyed bugs were estimated by sweep sampling across a row (4) with a 38-cm-diam sweep net. Ten random samples of 10 sweeps each were taken weekly in treated and untreated areas of each field. Individual sweep samples were placed in plastic bags, put in an ice chest and kept cool during transport to the laboratory, and frozen until processed.

Densities of adult red imported fire ants, adult earwigs, and adult and larval ground beetles were estimated by pitfall sampling (3). Five, 15-cm-diam pitfall traps were randomly placed in treated and untreated areas of each field immediately following chlorpyrifos application. Peanut plants from 30 cm of row were removed at each sample location prior to trap placement, and a pitfall trap established directly within the row. Aluminum, 30-cm-diam shields were hung directly over pitfall traps to deflect water, and reservoirs of 100% ethylene glycol were maintained in inside bottoms to kill and preserve collected arthropods. Individual trap captures were collected bimonthly and returned to the laboratory for processing.

Effects each year of chlorpyrifos on densities of individual pests and natural enemies were determined by using analyses of variance. Data were analysed as a split-plot in time randomized complete block, with insecticide treatments as whole plots and dates as subplots (8). The main effect of chlorpyrifos treatment was a comparison of seasonal density between treated and untreated areas. The insecticide treatment*date interaction was used to determine if the response to chlorpyrifos was the same on all sample dates.

Results and Discussion

Densities of fall armyworm were low on all sample dates, with estimates greatest on the last three sample dates each

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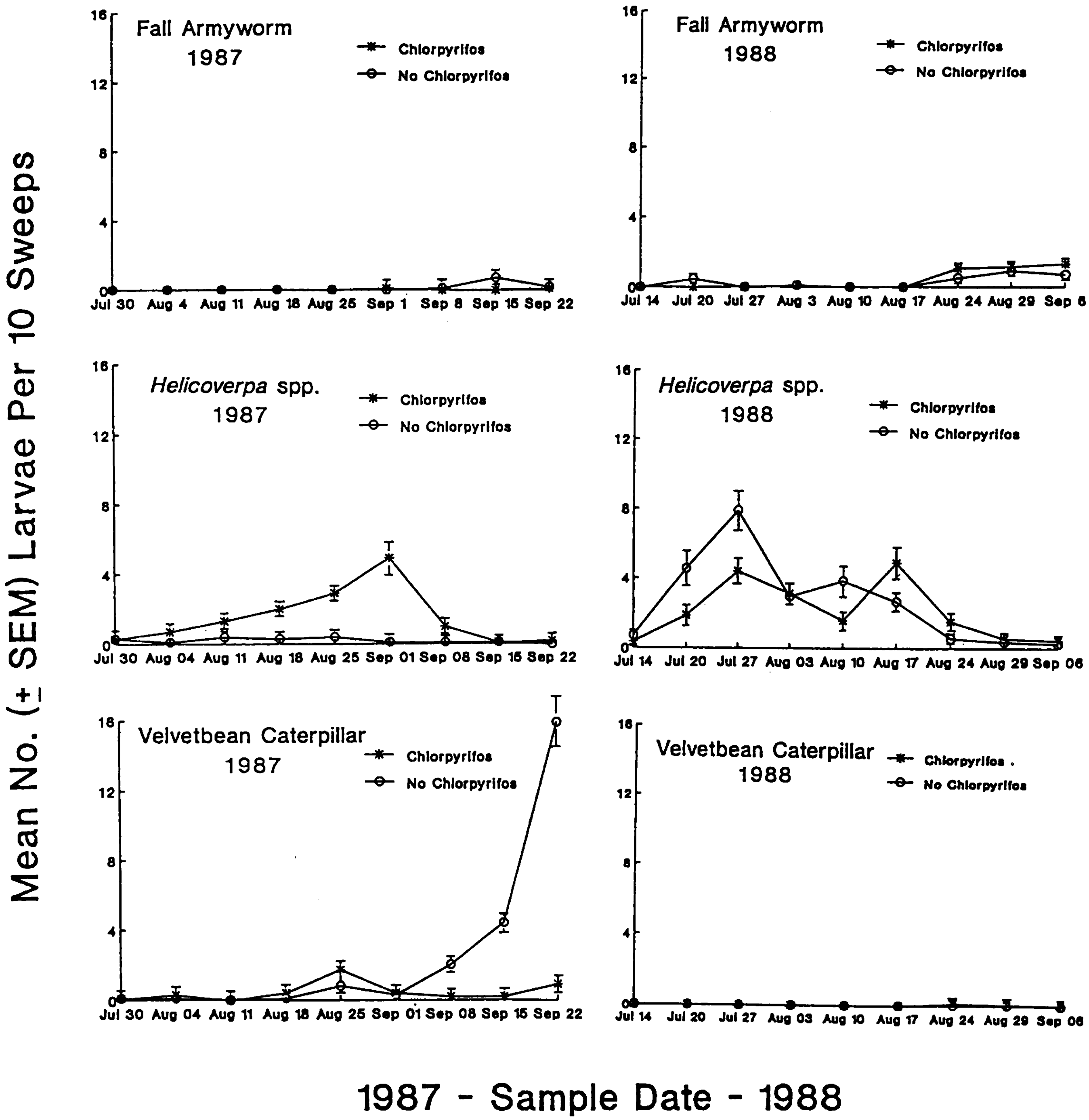

Fig. 1. Mean numbers (± SEM) of larval fall armyworms, *Helicoverpa* spp., and velvetbean caterpillars per 10 sweep samples in chlorpyrifos-treated and untreated areas of peanut fields sampled on nine dates in 1987 and 1988 in Jackson Co., Florida.

year (Fig. 1). Seasonal density was not affected by chlorpyrifos treatment in 1987 (F = 1.8; df = 1,3; P > 0.05) or 1988 (F = 1.0; df = 1,1; P > 0.05). The date*chlorpyrifos treatment interaction was not significant in 1987 (F = 1.6; df = 8,48; P > 0.05) or 1988 (F = 0.3; df = 8,16; P > 0.05).

Helicoverpa spp. were the most abundant defoliating pests in both 1987 and 1988 (Fig. 1). In 1987, more *Helicoverpa* were found in chlorpyrifos treated areas than in untreated areas on all individual sample dates (F = 11.5; df = 1,3; P < 0.05). Because densities were very low in both treatments on the last two sample dates, the date*chlorpyrifos treatment interaction also was significant (F = 2.4; df = 8,48; P < 0.05). Seasonal density of *Helicoverpa* spp. was statistically similar in treated and untreated areas of the peanut fields in 1988 (F = 13.2; df = 1,1; P > 0.05). The date*chlorpyrifos interaction also was not significant (F = 2.5; df = 8,16; P > 0.05).

Velvetbean caterpillar populations were very low in treated and untreated areas of each field in 1987, except during the last three sample dates (Fig. 1). Seasonal density was less in treated than untreated areas (F = 11.7; df = 1,3; P < 0.05), and the date*chlorpyrifos treatment interaction also was

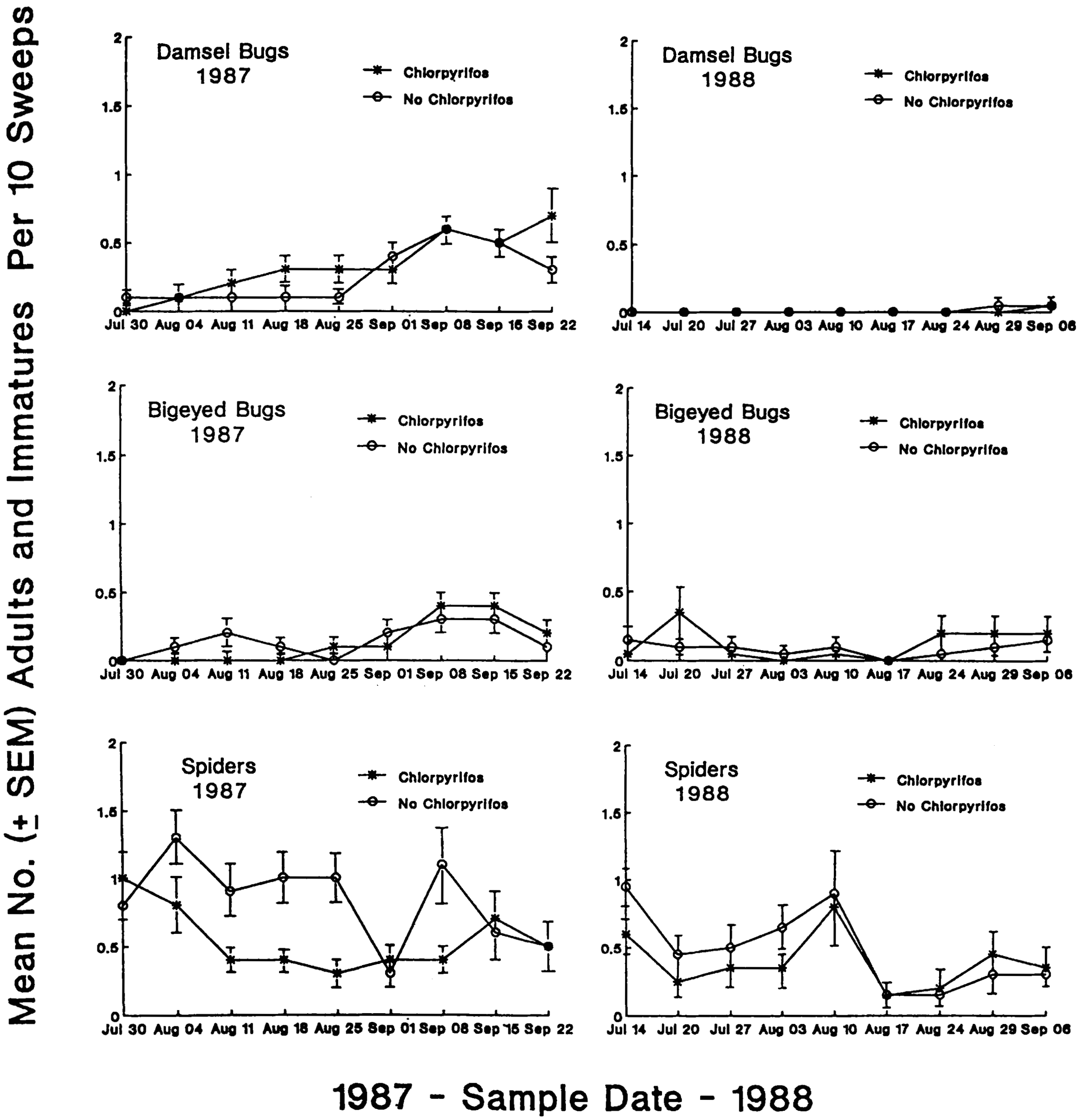

Fig. 2. Mean numbers (± SEM) of damsel bugs, bigeyed bugs, and spiders per 10 sweep samples in chlorpyrifos-treated and untreated areas of peanut fields sampled on nine dates in 1987 and 1988 in Jackson Co., Florida.

significant (F = 15.1; df = 8,48; P < 0.001). Velvetbean caterpillar populations were very low on all sample dates in 1988. Seasonal density was similar in treated and untreated areas (F = 0.1; df = 1,1; P > 0.05), and the date*chlorpyrifos treatment interaction was not significant (F = 0.1; df = 8,16; P > 0.05).

Predators captured by sweepnets were damsel bugs, bigeyed bugs, and spiders (Fig.2). Damsel bug species in each peanut field were *Reduviolus roseipennis* Reuter, *Nabis capsiformis* Germar and *R. alternatus* (Parshley). The abundance of damsel bugs was not affected by treatment with chlorpyrifos. The main effect of chlorpyrifos treatment on damsel bugs was not significant in 1987 (F = 2.2; df = 1,3; P > 0.05) or 1988 (F = 1.0; df = 1,1; P > 0.05). The date*chlorpyrifos interaction also was not significant in 1987 (F = 0.9; df = 8,48; P > 0.05) or 1988 (F = 0.3; df = 8,16; P > 0.05). Bigeyed bug species in each peanut field were *Geocoris punctipes* (Say).and *G. uliginosis* (Say). The main effect of chlorpyrifos treatment was not significant in 1987 (F = 0.0; df = 1,3; P > 0.05) or 1988 (F = 0.1; df = 1,1; P > 0.05), and the date*chlorpyrifos treatment interaction was not significant in 1987 (F = 0.8; df = 8,48; P > 0.05) or 1988 (F

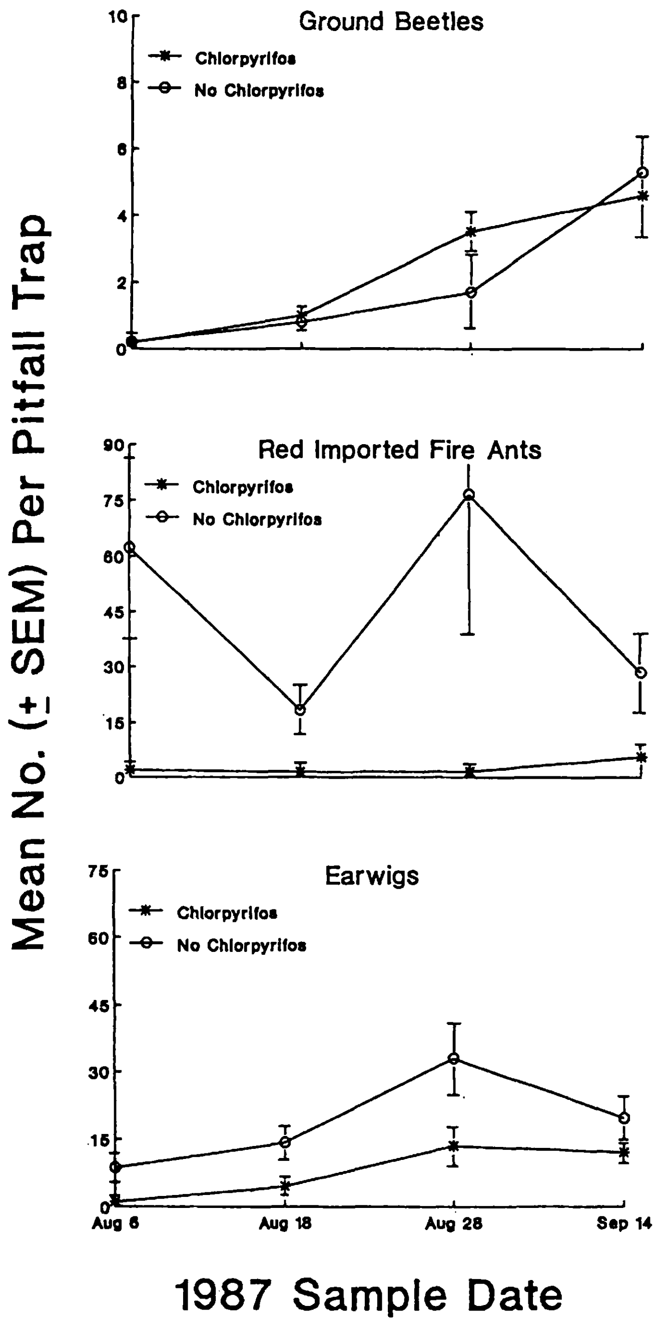

Fig. 3. Mean numbers (± SEM) of ground beetles, red imported fire ants, and earwigs per pitfall trap in chlorpyrifos-treated and untreated areas of peanut fields sampled on four dates in 1987 in Jackson Co., Florida.

= 0.5; df = 8,16; $P > 0.05$).

Abundance of spiders declined in plots treated with chlorpyrifos in 1987, but not 1988 (Fig. 2). In 1987, density was lower in treated than in untreated areas for several weeks following application, but was similar in treated and untreated areas for the remainder of the growing season. The main effect of chlorpyrifos treatment was not significant (F = 2.3; df = 1,3; $P > 0.05$), but the date°chlorpyrifos treatment interaction was significant (F = 2.6; df = 8,48; $P < 0.05$). The main effect of chlorpyrifos treatment was not significant in 1988 (F = 15.9; df = 1,1; $P > 0.05$), and the date°chlorpyrifos treatment interaction was not significant (F = 0.5; df = 8,16; $P > 0.05$).

The predators captured in pitfall traps were ground beetles, red imported fire ants, and earwigs. Frequent heavy rains invalidated results for all sample dates in 1988. Precision of density estimates in 1987, based on SEM's, was poor for red imported fire ants, ground beetles, and earwigs (Fig. 3). No significant differences were noted. Few red imported fire ants were collected on any sample date in plots treated with chlorpyrifos. However, the main effect of chlorpyrifos treatment only approached significance (F = 5.7; df = 1,3; P = 0.09). Nearly all of the earwigs in the pitfall samples were *Labidura riparia* (Pallas). The main effect of chlorpyrifos treatment was not significant for earwigs in 1987 (F = 3.4; df = 1,3; $P > 0.05$), despite much lower densities in treated than in untreated areas on all sample dates. Densities of ground beetles (*Calosoma* spp.) were equivalent in treated and untreated areas on each sample date, and the main effect of chlorpyrifos treatment was not significant (F = 0.2; df = 1,3; $P > 0.05$). The response of populations of red imported fire ants, earwigs, and ground beetles to chlorpyrifos application was the same on all sample dates (F = 1.1, 0.2, and 1.4, respectively; df = 3,18; $P > 0.05$).

Granular chlorpyrifos applied during the early pod stage of peanut growth for control of soil-insect pests resulted in direct and indirect effects on populations of defoliating pests. Velvetbean caterpillar populations declined in plots treated with chlorpyrifos. *Helicoverpa* spp. populations sometimes increased due to chlorpyrifos application. Increases in defoliator populations in treated areas probably resulted from indirect effects of chlorpyrifos on populations of natural enemies. Spider densities were reduced by chlorpyrifos treatment. Although results from pitfall sampling were inconclusive, the data indicate that red imported fire ants and possibly earwigs were directly reduced by chlorpyrifos application. However, other natural enemies were not affected, including damsel bugs, bigeyed bugs, and ground beetles. Our results demonstrate that chlorpyrifos for control of soil-insect pests will result in nontarget effects on defoliating pests. However, these effects can increase or decrease the possibility of an outbreak. Based on our findings, peanut fields should continue to be treated with soil insecticide when economically justified. However, treated fields should be scouted regularly, because such fields may have an increased potential for outbreaks of some defoliating pests.

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