INSECT POPULATIONS IN A COVER CROP/STRIP TILLAGE SYSTEM

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Abstract

Conservation tillage and the use of cover crops can provide multiple benefits to growers, but the effects of these practices on insect populations in cotton are not well defined. A replicated large-plot (1 acre each) test was undertaken to evaluate 5 different cotton production systems: (1) conventional plowing and cultivation; (2) growth of a rye cover crop, followed by conventional tillage prior to planting cotton; (3) growth of a crimson clover cover crop, followed by conventional tillage prior to planting cotton; (4) growth of a rye cover crop, and planting of cotton into row-tilled strips; and (5) growth of a crimson clover cover crop followed by planting of cotton into row-tilled strips. These treatments were sampled twice weekly for insects. The results of only treatments 1, 4, and 5 are reported here. None of the treatments had appreciable effects on heliothine egg or larval populations. Cotton aphid populations were also similar among treatments during July, but increased significantly in the conventionally-tilled plots in August. Natural enemy populations were similar among treatments, with the exception of the red imported fire ant, which was more abundant in the conservation tillage plots than in conventionally-tilled ones. No correlations were observed between pest and natural enemy populations. Yield variation was unrelated to insect populations, but was influenced by tillage and cover crops.

Introduction

Cover crops used in conjunction with conservation tillage can provide multiple benefits to growers, including reduced soil erosion, improved water drainage and moisture retention, increased organic matter, reduced weed pressure, and improved time management (Sprague and Triplett 1986). However, the reported effects of these practices on insect populations in cotton are conflicting and not well defined. Results vary with the cover crops used and the region in which the trials were conducted. In some reports pest pressure was enhanced when cover crops and conservation tillage were employed (e.g., Leonard et al. 1992, 1993). The increased pressure was due primarily to enhanced cutworm populations, although this problem appears to be worse when legume cover crops are used than is the case with other cover crops (Gaylor and Foster 1987, Sullivan and Thomas 1993). Some other pests, such as aphids, have also been reported to be worse where cover crops and conservation tillage are used (Ruberson et al. 1995), although in some instances aphid populations were reduced in such systems (Leser 1995). The effects on other pests, such as budworms and bollworms, are also quite variable (Gaylor and Foster 1987, De Spain et al. 1992, Leonard et al. 1992, Sullivan and Thomas 1993). Beneficial arthropods can also be affected by the level of tillage and the presence or absence of cover crops. Previous work has suggested that some species of natural enemies, such as the red imported fire ant, *Solenopsis invicta*, are more numerous in conservation tillage systems, while other species may be reduced (Ruberson et al. 1995). The purpose of the work reported here was to evaluate the effects of row tillage and cover crops on pest and beneficial arthropod populations in cotton.

Materials and Methods

A 30-acre, non-irrigated field in Tift County, Georgia, was divided into 30 1-acre plots. The field had been planted in peanuts in 1995, and had been plowed with a conventional moldboard plow in the fall of 1995 after the peanut harvest. The experimental design consisted of two tillage treatments (strip and conventional) and three cover treatments (crimson clover, rye, and none). Twelve of the plots were planted with crimson clover (12 lbs/acre; var. 'Dixie') and 12 others were planted with rye (50 lbs/acre; var. 'Wrens Abruzzi') on 5 January 1996. The remaining 6 plots had no cover crop planted into them. In the spring of 1996 the cover crops in half of the plots planted with cover crops were burned down with herbicide (glyphosate). The other half of the cover crop plots were conventionally tilled and the cover crop residue incorporated into the soil. Three weeks after terminating the cover crops, the seedbeds in the conservation tillage plots were row-tilled (12 inches wide) and cotton seed (var. DPL 5690) was planted in all plots (1 June). All plots were treated with 3 lbs of aldicarb in furrow at planting. The cotton was planted into the strip, leaving the dead cover crop residue intact between the rows. All of the plots were evaluated for nematodes, seedling diseases, and plant density by cooperators in the project. These findings are not reported here.

Insect sampling was initiated when the plants had 3-4 true leaves (23 June) and was conducted twice weekly until 9 September. Sampling consisted of several approaches: 1) whole plant observations (8 plants per plot), 2) shake cloth samples (4 samples of 3-row feet per plot), and 3) sweep samples (2 25-sweep samples per plot). All insects observed were identified and recorded. Insecticide applications were triggered when established pest thresholds were exceeded in the plots of 2 or more treatments. Insecticides were applied field-wide rather than in specific plots. Insecticide (cypermethrin at 0.025 lbs AI per acre) was applied twice during the season: 16 August and 4

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September. The results reported here will be only those from 3 of the 5 treatments (conventional tillage/no cover crop, strip tillage/crimson clover, and strip tillage/rye), as analyses of the project are still underway and a complete examination cannot yet be conducted.

Results and Discussion

Pest Populations

Pest pressure was relatively light throughout most of the season. No cutworms were observed in any of the plots. Thrips populations were also exceptionally light. The number of heliothine (tobacco budworm [*Heliothis virescens*] and cotton bollworm [*Helicoverpa zea*]) eggs was greater in the strip tillage plots during most of July (Fig. 1). Egg numbers increased considerably in August, but differed little among treatments in timing or total numbers. Observations of adult moths in the field inidcated that the majority of eggs were likely cotton bollworm rather than tobacco budworm.

Numbers of heliothine larvae were low through much of the season, but treatment thresholds were exceeded in late August and in early September (Fig. 2). In August, thresholds were exceeded in the strip-tilled clover and rye plots, but not in the conventionally-tilled plots. In contrast, the reverse occurred in September, with very low numbers of larvae present in the strip-tilled plots. The overall low heliothine levels were consistent with patterns observed throughout the area. There appeared to be no clear effects of treatment on larval populations of heliothines.

Cotton aphid populations were similar in all treatments throughout July, peaking in the third week of the month in all plots (Fig. 3). At this time, the entomopathogenic fungus *Neozygites fresenii* became widespread and rapidly reduced aphid numbers in all plots. In August, aphid populations increased in all plots, but peaked considerably higher in the conventionally-tilled plots than in the strip-tilled ones. The populations in all treatments subsided rapidly in response to the fungal epizootic and a variety of predators, including lady beetles and hover flies. In previous studies, we have observed a more rapid aphid buildup in conservation tillage plots and fields than in conventional ones. This rapid buildup, however, is typically followed by a more precipitous decline in conservation-tilled cotton, such that the subsequent aphid populations remain low throughout the remainder of the season where tillage is reduced.

This difference in aphid population growth between conservation-tilled cotton and conventionally-tilled cotton is often correlated with the increased fire ant activity prevalent in reduced tillage fields (see below). Fire ants often move up onto plants more actively when aphid populations are present, and actively defend the aphids from predators, such as lady beetles and lacewings. Elimination or reduction of aphid predators by fire ants probably enhances aphid population growth.

Other studies have noted reduced populations of heliothine species in conservation-tilled cotton, but increased problems with these species have also been reported (see Sullivan and Smith 1993). Cutworm problems failed to materialize in any of our test plots, so we can draw no conclusions relevant to this pest. Cotton aphid populations have been reportedly higher in reduced-tillage cotton in the Mid-South (Leonard 1995) and Southeast (Ruberson et al. 1995). However, we observed no intensification of aphids in the reduced-tillage plots; on the contrary, aphids were more abundant in the conventionally-tilled plots in August. The mechanisms for this second peak in the aphid populations in August are unknown.

Natural Enemy Populations

A variety of natural enemies was observed and counted in the plots. The total numbers of beneficial arthropods were lower than experienced in previous years; nevertheless, here we focus on the results for a few of the more abundant species.

One important natural enemy species in cotton is the big-eyed bug *Geocoris punctipes*. This predator was consistently observed in plots, but occurred at low levels throughout July (Fig. 4). Populations increased in mid-August, then declined toward the end of the month. Populations were increasing rapidly as sampling ended in September. No differences were observed among treatments; population trends were similar among all treatments during the sampling period (Fig. 4). Insecticide applications had no apparent effects on the predator's populations.

The insidious flower bug, *Orius insidiosus*, is also an important predator of many insect pests of cotton. Like *G. punctipes*, populations of *O. insidiosus* were very low throughout the sampling period (Fig. 5). There was considerable variability in the populations among sampling dates, treatments, and plots, but populations were generally larger in August than was the case in July. There were no differences attributable to treatment, nor did insecticide appllications appear to have any appreciable, consistent effect on the populations.

As noted above, the red imported fire ant, *Solenopsis invicta*, is often more abundant where conservation tillage is utilized. In our study, this same pattern emerged (Fig. 6). Fire ants were more abundant in the row-tilled plots during most of July and much of August. Fire ants are highly effective predators of many pests and can provide substantial levels of pest suppression. But fire ants also protect cotton aphids and make scouting considerably less enjoyable. Our results indicated no relationship between fire ant activity on plants (as indicated by shake sample numbers) and the number of aphids on leaves. More detailed analyses of whole-plant observations will be conducted to examine this relationship more fully.

Combined totals of all natural enemy species were consistently higher in the row-tilled plots in July, but numbers were similar among all treatments in August (Fig. 7). This stabilization of numbers among treatments may have been the result of natural enemy movement among plots. The numbers of natural enemies did not necessarily correlate with overall pest numbers. This may have been due to the generally low populations of both pest and beneficial species.

Final yields for the plots are presented in Table 1. The yield was numerically highest in the row-tilled rye plots, and lowest in the row-tilled clover plots. Both the conventionally-tilled plots and the row-tilled rye plots yielded significantly more lint than did the row-tilled clover plots. Analysis of effects of tillage and cover crop revealed that both of these factors influenced yields.

Table 1. Yield (lbs. lint cotton) in relation to tillage method and cover crop.

Tillage practice	Cover crop	Yield[1]
Conventional	None	763 ± 59.3 A
Row tillage	Rye	803 ± 155.1 A
Row tillage	Crimson clover	615 ± 158.8 B

[1]Means in the column followed by the same letter are not significantly different (Waller-Duncan Bayesian k ratio; k=100).

Summary

Overall, pest populations were low throughout most of the season, and were unaffected by tillage practice or cover crop. Beneficial arthropod populations were also low, but were typically higher in the row-tilled plots than was the case for the conventionally-tilled plots. Cover crop had no significant effect on beneficial arthropod populations independent of the tillage practice. There was, however, no clear relationship between numbers of beneficial and numbers of pests in the treatments. Yields were lower in row-tilled crimson clover plots than in the other treatments, suggesting that this plant may not be an ideal cover crop for conservation tillage operations. In contrast, the row-tilled rye plots yielded well and supported a large complex of natural enemies. These data suggest that small grains can provide an excellent cover crop for reduced tilage production. Data from multiple years at the same site are needed to validate these observations for long-term production.

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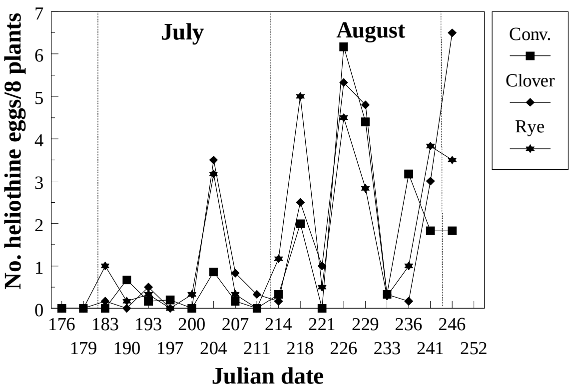

Figure. 1. Number of heliothine eggs per 8 plants in conventionally-tilled (conv.) plots and row-tilled plots with crimson clover or rye cover crop residues.

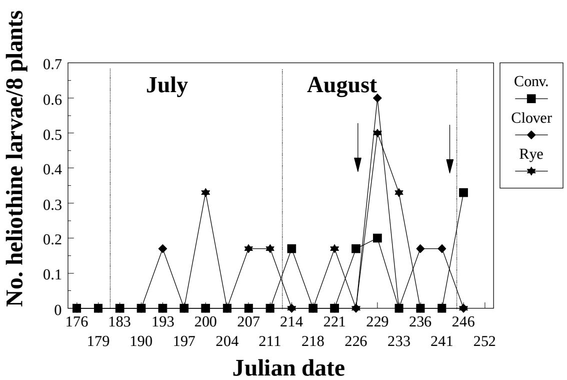

Figure. 2. Number of heliothine larvae per 8 plants in conventionally-tilled (conv.) plots and row-tilled plots with crimson clover or rye cover crop residues. Arrows indicate dates of cypermethrin sprays

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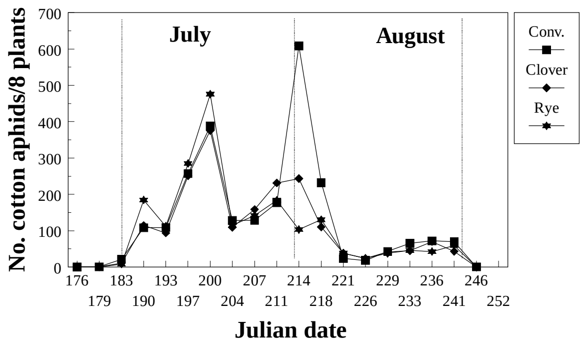

Figure. 3. Number of cotton aphids per 8 plants (counted on 2 leaves per plant) in conventionally-tilled (conv.) plots and row-tilled plots with crimson clover or rye cover crop residues.

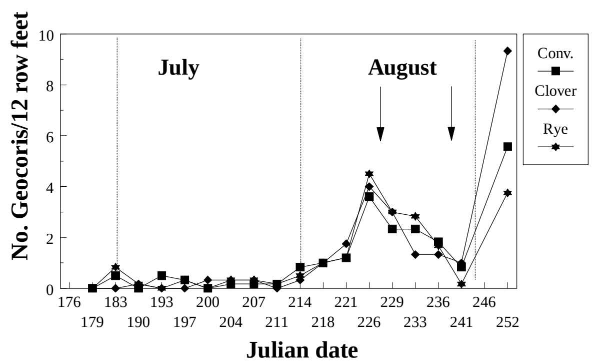

Figure. 4. Number of big-eyed bugs (*Geocoris punctipes*) per 12 row feet (4 3-row foot shake samples per plot) in conventionally-tilled (conv.) plots and row-tilled plots with crimson clover or rye cover crop residues. Arrows indicate dates of cypermethrin sprays.

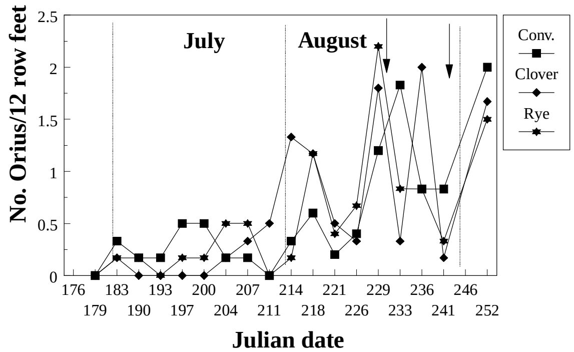

Figure. 5. Number of insidious flower bugs (*Orius insidiosus*) per 12 row feet (4 3-row foot shake samples per plot) in conventionally-tilled (conv.) plots and row-tilled plots with crimson clover or rye cover crop residues. Arrows indicate dates of cypermethrin sprays.

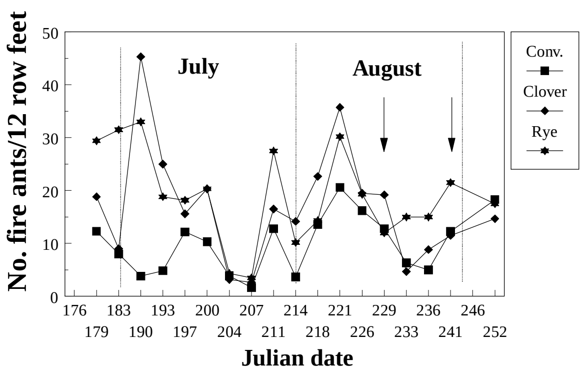

Figure. 6. Number of red imported fire ants (*Solenopsis invicta*) per 12 row feet (4 3-row foot shake samples per plot) in conventionally-tilled (conv.) plots and row-tilled plots with crimson clover or rye cover crop residues. Arrows indicate dates of cypermethrin sprays.

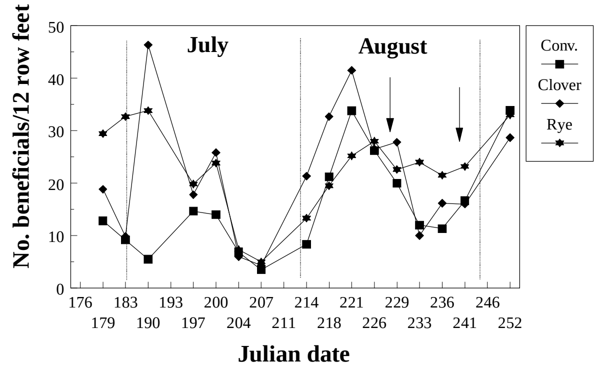

Figure. 7. Number of all beneficial arthropods per 12 row feet (4 3-row foot shake samples per plot) in conventionally-tilled (conv.) plots and row-tilled plots with crimson clover or rye cover crop residues. Arrows indicate dates of cypermethrin sprays.