Rye Cover Crop, Surface Tillage, Crop Rotation, and Soil Insecticide Impact on Thrips Numbers in Cotton in the Southeastern Coastal Plain[1]

Donald G. Manley, John A. DuRant,[2] Phil J. Bauer,[3] and James R. Frederick[4]

Department of Entomology, Clemson University, Pee Dee Research and Education Center, Florence, South Carolina 29506

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ABSTRACT Cover crops and conservation tillage are becoming increasingly important in cotton production in the southeastern United States. It is important to know the effects of changing cropping practices on pest populations. Thrips were collected from cotton seedlings rotated with corn or after a rye winter cover crop, either tilled or untilled, and either with or without aldicarb application. Insecticide application was effective in reducing thrips populations under nearly all cropping practices. No-till plots usually had fewer thrips than plots that were tilled. In 1 year, thrips populations were lower in rye/no-till plots than in no cover crop/no-till plots, but were higher in rye/tilled than in no cover crop/tilled.

KEY WORDS cotton, thrips, no-till, cover crops, aldicarb

Cover crops and green manures have long been used in southeastern United States cropping systems. Their use is gaining broader acceptance because they are an important component of new conservation tillage systems. For example, Bauer & Busscher (1996) found that using conservation tillage to produce cotton on the Coastal Plain may require a winter cereal to obtain a sufficient residue cover. With conservation tillage, cotton following rye had greater yield than cotton following legumes and fallow winter covers. Surface residues may also help control weeds by both physical and chemical means. Residues act as a physical barrier to seed germination of some weed species (Kimber 1967, Crutchfield et al. 1985). Also, numerous chemical compounds in wheat residues may suppress weed growth (Lynch 1977, Lodhi et al. 1987). This would give crop plants a competitive advantage, reduce the need for herbicides, and result in lower input costs.

Damage and control costs from insect pests often significantly reduce economic returns from cotton and soybean production in the southeastern United States.

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[2]Retired, Department of Entomology, Clemson University, Pee Dee Research and Education Center, Florence, South Carolina 29506.

[3]USDA, ARS, Coastal Plains Soil, Water, and Plant Conservation Research Center, Florence, South Carolina 29502.

[4]Department of Crop and Soil Environmental Science, Clemson University, Pee Dee Research and Education Center, Florence, South Carolina 29506.

Little is known about the combined impact of cover crops, rotation, and conservation tillage on pest dynamics and management in southeastern crop ecosystems. Pest pressure may change as these production practices are implemented. Natural enemies of insect pests (predaceous arthropods, parasitoids, and diseases) can propagate in one crop and be effective against pest insects in subsequent crops (Daigle et al. 1988, McCutcheon et al. 1997). Correspondingly, the presence of soil surface residues may cause increases in densities of pests such as armyworms and cutworms. Laub & Luna (1991) found that rye, used as a winter cover crop for no-till corn, produced fewer armyworms when mowed than when killed by paraquat. Two possible reasons for this response are: 1) mowing may physically destroy some larvae, and 2) the mulch made during mowing may provide a favorable habitat for predators of the armyworms. McCutcheon et al. (1995) reported that densities of fire ants were greatest in cotton plots that had a clover cover and were not cultivated. Tobacco budworm/cotton bollworm egg reductions were also detected in uncultivated cotton plots having a clover cover crop. Roach (1981) found that more bollworm and tobacco budworm moths emerged from reduced-till cropland than from conventionally tilled cropland.

The primary objective of this study was to determine the combined effects of cover crop, conservation tillage, and rotation on population dynamics and management of thrips in cotton in the southeastern coastal plain. The effects of surface tillage (disked versus not disked) and continuous cotton grown with and without a rye winter cover crop on thrips populations were determined over a 3-year period. In 1-year of the three, the comparison included cotton rotated with corn.

Materials and Methods

These tests were conducted in a field on Clemson University's Pee Dee Research and Education Center, near Florence, South Carolina, from 1997 through 1999. The experimental design was split-plot with whole plots in a randomized complete block. Whole plots were the cover and tillage combinations whereas subplots were the aldicarb levels. Treatments were the same in 1997 and 1999. They included continuous cotton with both disking and no surface tillage, continuous cotton after a rye winter cover crop with both disking and no surface tillage, and cotton rotated with corn with both disking and no surface tillage. The cotton plots were further subdivided into those receiving aldicarb (treated in-furrow with 1.18 kg AI ha^{-1} of Temik® 15G, Rhône-Poulenc Ag Company, Research Triangle Park, North Carolina) and those not receiving aldicarb. In 1998, the corn plots were rotated into cotton, with both disking and no surface tillage. All subplots (Temik® treatments) were six rows wide and ranged in length from 112 to 213 m. This report is part of a larger study investigating residue cover and tillage across different soil map units. Subplot length varied across the experimental area so that all soil types were included in each plot. All subplots were divided into 15.2-m sub-subplots. Row spacing was 1.0 m. There were three replications of each treatment.

Cotton seedlings were monitored for thrips each year beginning at the one-true-leaf stage. They were monitored on 20 May and 28 May in 1997, 26 May and 1 June in 1998, and 24 May, 1 June, 7 June, and 14 June in 1999. Ten randomly selected plants in each of four sub-subplots per plot were collected by cutting the plants about 2.5 cm above the soil surface. Plants were immediately placed in 946-ml glass jars containing approximately 227 g of 70% ethyl alcohol, sealed with removable lids and transported to the laboratory where all thrips specimens were separated from the plants using a plant washing technique in which the plant material was shaken vigorously in the alcohol to dislodge all thrips. The alcohol was poured into a 200-mesh sieve. Water containing a small amount of detergent was used to wash the thrips into a 500 ml beaker. This water was poured into a Buchner funnel attached to a vacuum device which suctioned the water through lined filter paper, leaving the thrips on the paper. The thrips were then identified and counted using a binocular microscope. Representative specimens of flower thrips, *Frankliniella tritici* (Fitch), western flower thrips, *F. occidentalis* (Pergande), and tobacco thrips, *F. fusca* (Hinds), were forwarded to specialists at the Georgia Coastal Plain Experiment Station, Tifton, Georgia, for positive identification.

The data were analyzed by year and sampling date. All thrips data were transformed by calculating square root (insect count + 5). Transformed data were subjected to analysis of variance using the SAS GLM procedure (SAS Institute 1996) and means were separated using the Least Significant Difference method when main effects or interactions were significant at $P \leq 0.05$.

Results

In all years and on all sampling dates, both adult and immature thrips numbers were lower when aldicarb was applied. Neither tillage system nor residue type had a significant impact on thrips numbers when aldicarb was applied.

In 1997, both adult and immature thrips were significantly reduced by aldicarb on both dates when compared with no aldicarb (Table 1). There was no difference between the two tillage systems for either adult or immature thrips when aldicarb was applied. When aldicarb was not applied, thrips populations were lower in untilled plots than they were in disk-tilled plots for both adults and immatures on 20 May. On 27 May, there was no difference between tillage systems for adult thrips when aldicarb was not applied, but immature thrips numbers were lower for no-tillage than they were for disk tillage at that date. Residue cover (rye cover crop or winter fallow) did not influence either adult or immature thrips numbers in 1997.

In 1998, both adult and immature thrips numbers were significantly reduced by aldicarb on both sampling dates (Table 2). On 26 May, the tillage × aldicarb interaction was significant because there were fewer adult thrips in untilled plots than in disk-tilled plots when aldicarb was not applied, but there was no difference between these tillage systems when aldicarb was applied. This interaction did not occur for immature thrips numbers on the same date. On 1 June, the cover × aldicarb interaction was significant for adult thrips numbers. This interaction was attributed to magnitude differences, because a greater difference in numbers of adult thrips between aldicarb treated and untreated plots occurred in the fallow treatment, when compared with corn residues or rye cover crop residues (data not shown). Also on the 1 June sampling date, the cover × tillage × aldicarb interaction was significant for immature thrips numbers. Again, this interaction was due to differences in magnitude, not rank, between aldicarb treatments within tillage and cover crop treatment combinations.

Table 1. Effect of tillage and aldicarb on adult and immature thrips in cotton at two dates in 1997 at Florence, South Carolina, averaged over two winter covers.

		20 May				27 May			
		Adults		Immature		Adults		Immature	
Tillage	Aldicarb	TM	Mean	TM	Mean	TM	Mean	TM	Mean
		Thrips per 10 plants							
Disk	Yes	3.1	4.8 ± 1.5	2.2	0.0 ± 0.0	3.6	8.7 ± 2.1	2.4	0.7 ± 0.3
Disk	No	5.4	24.5 ± 2.9	2.9	3.7 ± 1.3	5.0	20.5 ± 2.2	9.8	91.8 ± 7.8
No-Tillage	Yes	2.7	2.3 ± 0.9	2.2	0.0 ± 0.0	3.1	4.7 ± 0.8	2.3	0.2 ± 0.2
No-Tillage	No	3.7	9.0 ± 0.7	2.4	0.7 ± 0.2	5.2	22.7 ± 3.3	5.8	29.8 ± 5.1
	LSD	0.5		0.4		n.s.[a]		0.9	
Analysis of variance results									
Source of variation	d.f.	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Cover (C)	1	1.75	0.23	0.75	0.42	0.08	0.79	0.22	0.65
Tillage (T)	1	31.59	<0.01	4.20	0.09	0.49	0.51	48.19	<0.01
C × T	1	4.13	0.09	0.75	0.42	1.04	0.35	2.22	0.19
Aldicarb (A)	1	119.36	<0.01	12.92	<0.01	44.39	<0.01	385.36	<0.01
C × A	1	0.00	0.98	0.97	0.35	0.36	0.57	0.76	0.41
T × A	1	16.80	<0.01	5.43	0.05	1.96	0.20	47.91	<0.01
C × T × A	1	0.07	0.79	0.97	0.35	0.79	0.40	2.10	0.19

Data presented are the transformed means (TM) and the numerical means ± the standard error of the mean. Mean squares and probability of greater *F* values for selected sources of variation (transformed data) are given at the bottom of the table.

[a]n.s., not significant for the tillage × aldicarb interaction.

Table 2. Effect of tillage and aldicarb on adult and immature thrips in cotton at two dates in 1998 at Florence, South Carolina, averaged over three residue types (fallow, rye, corn stubble).

		26 May				1 June			
		Adults		Immature		Adults		Immature	
Tillage	Aldicarb	TM	Mean	TM	Mean	TM	Mean	TM	Mean
		Thrips per 10 plants							
Disk	Yes	2.9	3.8 ± 0.6	2.3	0.2 ± 0.1	2.7	2.1 ± 0.4	2.7	2.4 ± 0.7
Disk	No	7.1	47.0 ± 6.4	2.4	0.8 ± 0.4	3.7	9.1 ± 1.1	15.8	250.3 ± 29.7
No-Tillage	Yes	2.8	2.8 ± 0.5	2.2	0.0 ± 0.0	2.6	1.8 ± 0.4	2.9	3.6 ± 1.4
No-Tillage	No	4.7	17.2 ± 1.4	2.6	1.8 ± 0.7	3.3	6.3 ± 1.1	7.9	63.6 ± 14.7
	LSD	1.0		n.s.[a]		n.s.		1.4	
Analysis of variance results									
Source of variation	d.f.	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Cover (C)	2	0.17	0.85	0.28	0.76	0.60	0.57	6.83	0.01
Tillage (T)	1	29.25	<0.01	0.67	0.43	3.07	0.11	70.45	<0.01
C × T	2	0.36	0.71	0.13	0.88	2.79	0.11	4.90	0.03
Aldicarb (A)	1	97.11	<0.01	6.14	0.03	90.36	<0.01	396.62	<0.01
C × A	2	0.01	0.99	0.06	0.94	3.80	0.05	6.70	0.01
T × A	1	13.08	<0.01	1.58	0.23	3.03	0.11	77.19	<0.01
C × T × A	2	0.06	0.95	0.03	0.97	2.96	0.09	3.12	0.08

Data presented are the transformed means (TM) and the numerical means ± the standard error of the mean. Mean squares and probability of greater *F* values for selected sources of variation (transformed data) are given at the bottom of the table.

[a]n.s., not significant for the tillage × aldicarb interaction.

The impact of residue types on thrips numbers on the 1 June 1998 sampling date, averaged over aldicarb levels, is shown in Table 3. There were no significant differences among treatment combinations for adult thrips numbers. For immature thrips numbers, there were fewer thrips in the untilled plots than there were in the disk-tilled plots for all three residue types. Residue type within the no-tillage system had an influence on immature thrips numbers on that date, because there were fewer immature thrips when cotton was grown following corn or following a rye winter cover crop than when cotton was grown in cotton stubble (Table 3).

Thrips numbers were low in 1999. Even so, differences did occur among treatment combinations for adult and immature thrips numbers on the four sampling dates. For adult thrips, numbers in cotton were lower when aldicarb was applied than when it was not applied on both 24 May and 1 June (Table 4). On those two dates, adult thrips numbers also differed for tillage systems. There were more thrips in the disk tillage than in untilled plots on 24 May. In contrast to every other sampling date in each year, there were more thrips in the untilled plots than in disk tillage on 1 June. It is not apparent why adult thrips numbers were higher in no-tillage than in disk tillage on this sampling date. On the 7 June sampling date, adult thrips numbers were again higher for disk tillage than for no-tillage. There were no differences due to either aldicarb or cover crop on the 7 June sampling date, and none of the factors measured had an effect on adult thrips numbers on 14 June (Table 4).

Numbers of immature thrips were extremely low on the 24 May 1999 sampling date and there were no differences among treatments (Table 5). On the other three sampling dates in 1999, there were fewer immature thrips in cotton treated with aldicarb than there were in untreated cotton. There were fewer immature thrips in untilled plots than there were in plots tilled by disking on all three June sampling dates in 1999. On the 1 June sampling date, the tillage × aldicarb

Table 3. Effect of residue type and tillage on adult and immature thrips in cotton on 1 June 1998 at Florence, South Carolina, averaged over both aldicarb levels.

		Adults		Immature	
Residue type	Tillage	TM	Mean	TM	Mean
		Thrips per 10 plants			
Corn	Disk	3.4	6.8 ± 1.8	8.0	87.5 ± 40.4
Corn	No-tillage	2.8	3.0 ± 0.6	4.4	17.5 ± 7.3
Fallow	Disk	3.1	4.8 ± 1.9	9.4	129.3 ± 58.4
Fallow	No-tillage	3.2	6.0 ± 2.1	7.1	62.0 ± 25.9
Rye	Disk	3.1	5.2 ± 1.9	10.3	162.3 ± 75.6
Rye	No-tillage	2.8	3.2 ± 0.8	4.6	21.3 ± 9.9
	LSD	n.s.[a]		1.7	

Data presented are the transformed means (TM) and the numerical means ± the standard error of the mean.

[a]n.s., not significant for the residue × tillage interaction.

Table 4. Effect of tillage and aldicarb on adult thrips in cotton at four dates in 1999 at Florence, South Carolina, averaged over three residue types (fallow, rye, corn stubble).

		24 May		1 June		7 June		14 June	
Tillage	Aldicarb	TM	Mean	TM	Mean	TM	Mean	TM	Mean
					Thrips per 10 plants				
Disk	Yes	2.5	1.3 ± 0.7	3.4	6.5 ± 1.0	3.6	7.8 ± 1.0	4.0	11.3 ± 1.3
Disk	No	3.9	10.7 ± 1.6	3.5	7.3 ± 1.3	3.3	6.3 ± 1.2	3.5	7.2 ± 1.2
No-Tillage	Yes	2.5	1.5 ± 0.4	3.3	6.2 ± 1.3	2.9	3.5 ± 0.9	3.4	6.5 ± 1.0
No-Tillage	No	3.3	6.0 ± 1.0	4.1	12.2 ± 1.3	2.9	3.8 ± 1.6	3.4	6.5 ± 1.8
	LSD	n.s.[a]		0.6		n.s.		n.s.	
Analysis of variance results									
Source of variation	d.f.	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Cover (C)	1	1.28	0.30	8.70	0.02	2.84	0.14	0.29	0.61
Tillage (T)	1	6.55	0.04	5.85	0.05	10.13	0.02	3.65	0.10
C × T	1	0.52	0.50	5.03	0.07	0.23	0.65	0.04	0.85
Aldicarb (A)	1	29.69	<0.01	7.43	0.03	0.24	0.63	2.02	0.19
C × A	1	0.66	0.44	0.01	0.94	0.62	0.45	0.01	0.93
T × A	1	2.81	0.13	4.22	0.07	0.39	0.55	1.63	0.24
C × T × A	1	0.16	0.70	2.14	0.18	0.76	0.41	1.16	0.31

Data presented are the transformed means (TM) and the numerical means ± the standard error of the mean. Mean squares and probability of greater F values for selected sources of variation (transformed data) are given at the bottom of the table.

[a]n.s., not significant for the tillage × aldicarb interaction.

Table 5. Effect of tillage and aldicarb on immature thrips in cotton at four dates in 1999 at Florence, South Carolina, averaged over three residue types (fallow, rye, corn stubble).

		24 May		1 June		7 June		14 June	
Tillage	Aldicarb	TM	Mean	TM	Mean	TM	Mean	TM	Mean
					Thrips per 10 plants				
Disk	Yes	2.2	0.0 ± 0.0	2.7	2.7 ± 1.3	3.0	4.2 ± 1.2	3.6	8.0 ± 1.6
Disk	No	2.3	0.5 ± 0.2	6.7	41.0 ± 8.0	5.1	21.2 ± 3.7	5.2	23.0 ± 4.2
No-Tillage	Yes	2.2	0.0 ± 0.0	2.3	0.3 ± 0.2	2.6	1.7 ± 0.9	2.7	2.3 ± 0.6
No-Tillage	No	2.3	0.2 ± 0.2	4.0	12.3 ± 3.8	3.4	7.2 ± 1.7	4.5	16.3 ± 4.9
	LSD	n.s.[a]		1.2		n.s.		n.s.	
Analysis of variance results									
Source of variation	d.f.	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Cover (C)	1	1.31	0.30	0.54	0.49	0.32	0.59	6.38	0.04
Tillage (T)	1	1.31	0.30	22.15	<0.01	16.33	<0.01	7.96	0.03
C × T	1	5.45	0.06	0.05	0.82	0.60	0.47	1.63	0.25
Aldicarb (A)	1	4.08	0.08	60.12	<0.01	21.35	<0.01	33.58	<0.01
C × A	1	0.98	0.40	0.09	0.77	0.13	0.72	4.47	0.07
T × A	1	0.98	0.40	9.27	0.02	3.40	0.10	0.05	0.83
C × T × A	1	4.08	0.08	0.57	0.47	0.39	0.54	0.08	0.78

Data presented are the transformed means (TM) and the numerical means ± the standard error of the mean. Mean squares and probability of greater *F* values for selected sources of variation (transformed data) are given at the bottom of the table.

[a]n.s., not significant for the tillage × aldicarb interaction.

interaction was significant because the difference between aldicarb-treated and untreated numbers was considerably larger for disk tillage than for the untilled plots. Overall, residue type (cotton stubble or rye cover crop) had little effect on either adult or immature thrips numbers in 1999.

Discussion

In all 3 years, and on most sampling dates, plots in which aldicarb had been applied usually had fewer thrips than plots in which no aldicarb was applied. Therefore, the insecticide application was effective in reducing thrips populations under nearly all conditions.

In all 3 years, and on most sampling dates, thrips numbers were generally lower with no-tillage than with conventional tillage. All et al. (1992) found fewer tobacco thrips for no-till systems than for conventional systems with surface tillage. They concluded that use of no-till may enhance integrated pest management of that pest. Our results agree with this earlier work. Interestingly, when thrips populations were high in 1998, cotton grown in corn or rye stubble had lower thrips numbers than cotton grown in cotton stubble. Further research is needed to verify this finding, and to extend it to other environments.

In conclusion, our data indicate that application of aldicarb insecticide at planting effectively reduced thrips populations. Though we did not quantify it, there was considerably less visual thrips damage on the cotton receiving aldicarb than on the cotton that did not. When aldicarb was not applied, we generally found lower thrips populations with no-tillage than with disk tillage. More research is needed to better define the residue combinations and environmental conditions that result in lower thrips populations.

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