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THE IMPACT OF DIFFERENT TILLAGE PRACTICES ON ARTHROPODS IN COTTON IN THE SOUTHERN ROLLING PLAINS OF TEXAS

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Abstract

Producers in the Southern Rolling Plains (SRP) of Texas are usually limited by moisture when producing cotton. Some producers are shifting their tillage practices from conventional to a reduced or conservation tillage program. Although conservation tillage can incorporate many different practices, producers in the SRP usually use the term to mean fewer trips and leaving more organic material at the surface. Producers are making the shift due to increasing fuel costs and managing labor and equipment costs. Producers have expressed concern that the shift to different tillage practices will lead to greater pest problems so a three year study was established to determine the impacts. In general, the shift to conservation tillage did not lead to greater pest problems. There were slight increases in grasshopper populations in the conservation tilled fields but grasshoppers never reached economic threshold levels in the three years of the study. Natural enemy populations were also impacted minimally between different tillage systems. Although advantages may be seen early in the growing season in reduced tillage systems, as with carabids, in general, neither tillage system favors natural enemies by the end of the season.

Introduction

Conservation or reduced tillage is being adopted by an increasing number of Texas farmers due to the perceived economic advantages of this system, the benefits to soil and water conservation and the availability of new technology including herbicide tolerant cotton and no-tillage planters. Changes in soil structure using conservation tillage systems increase water infiltration and organic matter which favors crop establishment, growth and yield. Environmental advantages of conservation or reduced tillage include less runoff of soil from fields. Conventional tillage systems dry the soil and bring more weed seeds to the surface relative to conservation tillage. Crop residues on the soil surface can also decrease wind damage and sandblasting of crops.

Although producers are beginning to adopt reduced tillage practices, the effects of these new tillage systems on pest populations in cotton have received little attention in Texas. For example, a recent economic analysis by Johnson and Polk (2004) of different farming operation in the SRP indicated that cost savings for labor, fuel, machinery, equipment, repairs and maintenance were offset by higher chemical costs due to a reliance on herbicides to manage weeds. Studies of this type indicate that producers need to look at all aspects of production when assessing the change of production practices.

In a review of conservation tillage studies, Stewart (2003) indicated that most data indicate that in-season pest populations are minimally affected by tillage operations. Lower thrips populations were associated with conservation tillage plots (All et al. 1992, Leonard 1995). Cotton aphid densities were higher in conservation tillage plots than in conventional tillage plots (Leonard 1995). Similar studies in Texas have been confounding. De Spain et al. (1990, 1992) reported that early season aphid numbers were elevated in reduced tillage plots compared to conventional tillage plots in three out of the four years of the study. These studies were conducted in the Lower Gulf Coast region of Texas where humidity levels are generally higher and the cropping system is composed of corn and grain sorghum. Leser (1995) reported fewer thrips and aphids in reduced tillage systems compared to conventional systems in the High Plains of Texas. Both Leser (1995) and Leonard (1995) reported higher survival of bollworm/tobacco budworm pupae in reduced tillage systems but both also noted that migration is probably a bigger factor in determining if this insect will be an economic pest in any particular season. The High Plains system is dominated by continuous cotton planted into terminated wheat.

Clearly, conservation tillage practices have both potentially positive and negative effects on both pest and beneficial populations in cotton. As these effects are unknown for cotton production in the SRP, results of this project may help plan IPM programs needed to fully realize the benefits of reduced tillage systems in cotton. Also, growers may

be reluctant to adopt conservation tillage because of perceived risks due to increased insect problems. Results of this study identify some of the risks and benefits relative to insect pests and thus speed adoption of conservation tillage.

Materials and Methods

Similar procedures were used throughout the three years (2002-2004) of the study. The project used farms located in Runnels County. In each instance, a conservation/reduced tillage field was compared to a conventionally tilled field located nearby. Three comparisons were made using a total of six fields.

Soil types and soil profiles were determined by the National Resource and Conservation Service (NRCS) to verify that the paired fields were of similar soil type and structure. Planting dates varied widely the three years of the study. Moisture conditions were favorable in 2002 and the crop was planted relatively early (mid-May) for the area. Moisture conditions were wet in 2003 and 2004 and in both years, cotton was planted in the second and third week of June, which is still within the normal planting window for the area.

Insect populations were monitored weekly by the Runnels/Tom Green IPM Program scouts beginning at plant emergence and continuing until nodes above white flower (NAWF) was equal to five. Insect densities were determined by scouting three consecutive whole plants in thirteen different locations in the field (four consecutive plants were scouted at the last location) for a total of 40 plants per field.

Pitfall traps were placed in the field at planting and were checked every five days from June to August. Twelve traps were place in each of the six fields by dividing the field into four quadrants and placing three pitfall traps 100 feet, 200 feet and 300 feet from the edge of the quadrant. Trap catches were brought back to the entomologist's office for identification to family except for the grasshopper and spider groups. Data were analyzed using a t-test.

Results and Discussion

2002

Table 1 shows the data for insect data taken from plants in 2002. All data are number per 40 plants except for the aphid counts which are the number per 40 leaves. No significant differences occurred with western flower thrips (*Frankliniella occidentalis* (Pergand)) or cotton fleahoppers (*Psuedatomoscelis seriatus* (Reuter)). Cotton aphid (*Aphis gossypii* Glover) numbers varied widely. Highest numbers were reached in the reduced tillage system; however, this was due primarily to one field. Aphids were generally higher in the conventional system throughout the season although none of the conventional fields reached the threshold of 50 aphids per leaf.

Table 1. Influence of tillage practices on the abundance of pest arthropod groups on 40 plants. Runnels County, 2002.

Date	Tillage	Thrips	CF[2]	Aphids/40 Leaves	H. eggs	H. larvae	Key predators
July 2	Conventional	21.00	2.67	6.67*[1]	1.66	0.00	8.00
	Reduced	21.67	0.00	25.00	1.00	0.00	7.33
July 9	Conventional	33.33	8.00	180.00**	11.00	0.00	23.33
	Reduced	41.67	3.33	0.00	3.33	0.00	21.67
July 16	Conventional		11.67	166.67**	12.33	0.00	59.33
	Reduced		6.33	2836.70	8.33	0.00	18.33
July 25	Conventional		8.33	173.33**	6.00	0.00	25.67
	Reduced		10.00	30.00	3.67	0.00	30.67
August 2	Conventional		10.67	0.00	8.67**	0.00	40.00
	Reduced		4.67	6.00	6.33	0.00	36.67
August 13	Conventional		14.00	358.33	12.00	0.00	29.33

	Reduced	8.33	266.67	12.67	0.00	43.33

1. Means for dates, within columns, followed by a * are significant at P<0.10; ** are significant at P<0.05
2. Acronyms are as follows: CF, cotton fleahopper; H. eggs, Heliothine eggs; H. larvae, Heliothine larvae

Bollworm/tobacco budworm numbers remained low throughout the season. Key predators (lady beetles, *Orius* spp., *Nabis* spp., spiders) had sampling differences but seasonal averages were very similar.

Table 2 shows the data for the pitfall traps throughout the season. Crickets are significantly more numerous in conventional tillage fields compared to reduced tillage fields on two dates and in general, throughout the season. However, grasshoppers are generally more numerous in reduced tillage systems. Two predator groups, the carabids and the histerids, are more numerous in the reduced tillage systems early in the season, but then carabids become more numerous in the conventional systems by early July.

Table 2. Influence of tillage practices on the abundance of pest arthropod groups as found in 12 pitfall traps. Runnels County, 2002.

Date	Tillage	Gryllidae	Grasshoppers	Carabidae	Spiders	Histeridae
June 18	Conventional	0.00	0.33	1.00**	0.00	0.67
	Reduced	0.67	0.00	6.00	0.00	1.33
June 26	Conventional	0.67	1.00	16.67*	1.00	0.00
	Reduced	0.33	4.00	39.67	2.67	1.00
July 2	Conventional	0.67	3.00	1.00**	1.00	0.33
	Reduced	0.67	0.00	23.00	2.00	0.00
July 8	Conventional	0.67	3.33**	18.00*	0.00	0.33**
	Reduced	0.67	5.33	3.67	0.00	13.00
July 16	Conventional	22.00**[1]	27.00	18.33	0.33	15.67
	Reduced	2.33	24.00	12.33	0.67	20.00
July 23	Conventional	18.33	5.67	42.00**	1.33	7.67
	Reduced	6.67	8.67	7.67	1.33	5.67
July 30	Conventional	26.00**	7.00	18.67	2.33	1.33
	Reduced	3.33	6.33	10.67	2.33	0.00
August 5	Conventional	17.67	6.67	15.33	0.33*	0.67
	Reduced	24.00	9.67	11.00	3.33	0.33
August 12	Conventional	42.67	3.67	26.00	1.67	0.00
	Reduced	30.00	6.67	19.33	0.00	1.67

1. Means for dates, within columns, followed by a * are significant at P<0.10; ** are significant at P<0.05

2003

Thrips and aphids were not a problem due to a later planting date in 2003. Cotton fleahopper numbers were significantly higher in the reduced tillage systems until late in the season. This is a complete reversal from 2002 when numbers were generally higher in the conventional systems. Heliothine numbers showed no obvious trends with numbers staying low throughout the season. The absence of aphids during the season shows up in key predator numbers. The numbers are approximately half of the 2002 season. As in 2002, no real trends are obvious from any of the plant data.

Cricket numbers are higher in conventional systems although only one date is significant in 2003 (Table 4). Grasshopper numbers are significantly higher in the reduced tillage systems throughout the season (Table 4). Both of these trends are similar to 2002 data. The carabids again are higher in the reduced tillage fields early in the

season and then higher numbers are present later in the season in the conventional tillage fields. The histerid data are not quite as clear since numbers are low (Table 4). Spider numbers are higher in 2003 compared to 2002 but data do not indicate that spiders prefer one system over another.

Table 3. Influence of tillage practices on the abundance of pest arthropod groups on 40 plants. Runnels County, 2003.

Date	Tillage	Thrips	CF[2]	Aphids/40 Leaves	H. eggs	H. larvae	Key predators
June 30	Conventional	0.00	0.33*[1]	0.00	1.00	0.00	7.33
	Reduced	0.00	2.33	0.00	1.00	0.00	9.00
July 7	Conventional	0.00	2.00**	0.00	2.33	0.00	4.33**
	Reduced	0.00	4.67	0.00	3.67	0.00	7.00
July 16	Conventional		5.33**	0.00	3.00	0.67	9.00
	Reduced		10.67	0.00	3.33	3.00	12.67
July 21	Conventional		8.33*	0.00	9.00	0.00	15.67
	Reduced		10.00	0.00	12.00	0.00	14.33
July 28	Conventional		13.67	0.00	18.67	0.00	18.67
	Reduced		12.00	0.00	22.00	0.00	21.33
August 4	Conventional		14.00**	0.00	7.67	3.00	18.67
	Reduced		7.33	0.00	12.00	2.67	36.00

1. Means for dates, within columns, followed by a * are significant at P<0.10; ** are significant at P<0.05
2. Acronyms are as follows: CF, cotton fleahopper; H. eggs, Heliothine eggs; H. larvae, Heliothine larvae

Table 4. Influence of tillage practices on the abundance of pest arthropod groups as found in 12 pitfall traps. Runnels County, 2003.

Date	Tillage	Gryllidae	Grasshoppers	Carabidae	Spiders	Histeridae
June 30	Conventional	11.33	0.67**	42.67	1.67	0.00
	Reduced	9.67	3.67	127.33	4.00	0.00
July 7	Conventional	23.00	0.67**	19.33**	2.67*	4.00*
	Reduced	13.00	6.33	48.33	12.00	7.33
July 16	Conventional	85.33*[1]	2.33*	18.00*	14.67	3.00**
	Reduced	19.67	5.33	28.33	15.00	0.33
July 21	Conventional	75.00	1.67	47.33**	16.33	0.00
	Reduced	47.00	4.00	16.33	14.00	0.00
July 28	Conventional	123.67	0.67**	2.67	4.67	0.00
	Reduced	140.33	4.00	6.67	10.00	0.33
August 4	Conventional	118.00	1.33**	1.67	4.33**	0.00
	Reduced	115.00	5.33	5.33	6.67	0.00

1. Means for dates, within columns, followed by a * are significant at P<0.10; ** are significant at P<0.05

2004

As in 2003, the planting date was delayed across the SRP due to dry conditions early and wet planting conditions at the best planting window. Thrips were not a problem due to the late planting and although aphids were present in other fields, the fields in this study had extremely low numbers (Table 5). Cotton fleahopper numbers were

significantly higher in the conventional tillage fields early in the season (Table 5). The population shifted approximately at one-third grown square stage to higher numbers in the reduced tillage fields. Heliothine eggs were higher in the reduced tillage fields than in the conventional fields but egg numbers did not result in larval populations. Key predator numbers were higher in the conventional fields throughout the season and this may be the reason that egg counts were lower in the conventional fields (Table 5).

Table 5. Influence of tillage practices on the abundance of pest arthropod groups on 40 plants. Runnels County, 2004.

Date	Tillage	Thrips	CF[2]	Aphids/40 Leaves	H. eggs	H. larvae	Key predators
June 28	Conventional	0.00	23.33**[1]	0.00	0.00	0.00	21.33
	Reduced	0.00	2.00	0.00	0.00	0.00	12.33
July 6	Conventional	0.00	19.33	0.00	5.00	0.00	25.33
	Reduced	0.00	9.33	0.00	6.67	0.00	15.67
July 12	Conventional		6.00	0.00	2.67	0.00	36.00
	Reduced		7.67	0.00	4.00	0.00	23.00
July 19	Conventional		6.67**	0.00	3.33*	0.00	24.00
	Reduced		11.00	0.00	8.67	0.00	15.33
July 26	Conventional		1.67**	0.00	18.67	2.00	30.33
	Reduced		12.67	0.00	15.33	0.00	28.67
August 2	Conventional		8.67	0.00	26.00**	2.67	22.33
	Reduced		2.67	0.00	30.33	1.00	17.33

1. Means for dates, within columns, followed by a * are significant at P<0.10; ** are significant at P<0.05
2. Acronyms are as follows: CF, cotton fleahopper; H. eggs, Heliothine eggs; H. larvae, Heliothine larvae

As in 2002 and 2003, cricket numbers are significantly higher in conventional tillage fields and grasshopper numbers are significantly higher in reduced tillage fields (Table 6). Carabid numbers are significantly higher in the reduced tillage fields but numbers are generally lower than in 2002 and 2003 (Table 6). Histerids were not present in 2004 (Table 6). Spider populations were similar to 2002 with only one date in the conventional fields having significantly higher numbers.

Table 6. Influence of tillage practices on the abundance of pest arthropod groups as found in 12 pitfall traps. Runnels County, 2004.

Date	Tillage	Gryllidae	Grasshoppers	Carabidae	Spiders	Histeridae
June 28	Conventional	13.00**[1]	2.33	6.33*	3.33	0.00
	Reduced	0.67	2.00	11.33	3.00	0.00
July 6	Conventional	31.00**	3.67**	6.00	7.00	0.00
	Reduced	2.33	8.00	8.00	5.33	0.00
July 12	Conventional	27.67**	2.67	2.00*	4.00*	0.00
	Reduced	1.67	5.67	5.33	3.33	0.00
July 19	Conventional	25.00	1.00	2.33	4.00	0.00
	Reduced	14.67	1.67	4.00	3.67	0.00
July 26	Conventional	60.33	2.00**	4.00	2.67	0.00
	Reduced	29.33	7.33	6.00	7.67	0.00

August 2	Conventional	36.33	2.00	4.33	1.67	0.00
	Reduced	20.00	4.67	3.00	1.67	0.00

1. Means for dates, within columns, followed by a * are significant at P<0.10; ** are significant at P<0.05

Conclusions

Producers change their production practices to reduced tillage systems due to benefits to the land and their management style. The reduced tillage systems minimize water and wind erosion and generally allow producers to either to reduce the amount of time invested in farming or to increase acreage. Most producers do not think about the consequences to insect pest management when making the change.

This study supports the results of other conservation tillage studies that indicate that moving to reduced tillage systems should not result in an increase in insect pest problems. Cutworms were not a problem in the three years of the study. The producers in the reduced tillage systems generally applied a herbicide to kill winter weeds at least four weeks prior to planting. This removed plant materials for the adult moths to lay eggs and removed the food source for the larvae.

Neither system favored thrips. The SRP producers generally plant later than most producers in Texas to take advantage of warmer planting temperatures and to take advantage of late season rainfall. The later planting also allows the cotton to escape the major thrips migration from winter wheat. Cotton fleahopper numbers were generally higher in the conventional fields. These fields tended to have more silverleaf nightshade early in the season which is a host of cotton fleahoppers. However, neither system followed the trend season-long. Cotton aphid numbers were low throughout the study, with only 2002 having significant numbers. As in the High Plains, aphid numbers were higher in the conventional system in 2002 but neither tillage system had severe problems. The Heliothine complex was not favored by either system. Although studies have shown that survivorship of overwintering populations are higher in reduced tillage systems, migration plays a major role in the severity of the problem. Grasshopper numbers were higher in the reduced tillage systems and this potentially may become a problem. Currently most grasshopper problems are generated from grasshoppers moving from rangeland to cultivated fields. Crickets were higher in conventional systems but never posed a hazard.

The reduced tillage systems did show higher numbers of ground predators and spiders early in the season. These predators may play a role in reducing the first generation populations. The impact of these ground predators is difficult to measure because most of them are active at night. As the season progressed, natural enemy populations became similar in both tillage systems.

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