COVER CROPS AND NITROGEN RATE TO OPTIMIZE IRRIGATED COTTON YIELDS WITH CONSERVATION TILLAGE

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Abstract

The loess soils of the Macon Ridge Area of Louisiana are easily eroded, contain low organic matter and are drought susceptible. The objective of this field study was to determine the effects of no-till practices and cover crops on cotton performance and determine the optimal fertilizer N rate for selected combinations of no-till and cover crops. The experiment treatments were no-till and conventional-till, winter cover crops of wheat, hairy vetch or native cover and N rates of 0, 35, 70,105, and 140 lb/acre.
From the initiation year 1991 through 1993, there was no difference in lint yield between tillage regimes. From 1992 through 1996, cotton in no-till averaged significantly higher lint yields than conventional-till. The cover crop x N rate yield interaction was significant. Cotton following hairy vetch produced higher yields with less fertilizer N than cotton following wheat or native vegetation. Following wheat, cotton lint yield was optimized at 1200 lb/acre with the application of 105 lb N per acre. Following hairy vetch, cotton lint yield was optimized at 1248 lb/acre with the addition of 35 lb N per acre. With native vegetation, cotton yields were optimized at 1233 lb/acre with the application of 70 lb N per acre.

Cover crop and N rate had a significant effect on node above white flower (NAWF) development and terminal internode length (TIL). Tillage did not affect these variables. An N rate of 70 lb/acre optimized NAWF and TIL in all cover crop treatments. All responses of NAWF and TIL were related to N availability, either as fertilizer or legume N.

Introduction

Adoption of conservation-tillage systems for highly erodible soils like those of the Macon Ridge area of Louisiana offers the most practical means of preserving soil productivity and reducing contamination of surface water with soil particles, fertilizer nutrients and pesticides. These systems may also offer an opportunity to reduce equipment, labor and fuel costs. On the negative side, conservation-tillage systems require more timely and intensive management than conventional production systems and usually require additional chemicals for pests.

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The effectiveness of conservation tillage in reducing wind and water erosion is due to the large amounts of plant residue that remains on the soil surface throughout the year. Although conservation tillage increases surface residue compared to conventional-tillage, planting of winter cover crops may also be necessary to provide adequate ground cover in cotton fields with a high erosion potential (Huchinson et al., 1991; Mutchler and McDowell, 1990). Winter cover crops may also improve the physical condition of the soil (Patrick et al., 1957; Scott et al., 1990). Yields of cotton in conservation-tillage systems are often improved with winter cover crops such as wheat or hairy vetch (Brown et al., 1985; Keeling et al., 1989). Legume cover crops provide nitrogen (N) to the following cotton crop and may reduce the need for fertilizer N (Boquet and Coco, 1993). A grass cover crop may immobilize N and increase the need for fertilizer N application (Hutchinson, 1991).

Objectives

To determine the effects of selected cover crops and N rates on cotton grown in no-till and conventional- till.

To determine the optimal N rate for cotton following selected cover crops in both no-till and conventional-till.

Materials and Methods

This study was conducted from 1991 through 1996 at the Macon Ridge Research Station in Winnsboro on Gigger silt loam (fine-silty, mixed, thermic Typic Fragidaulf). Two tillage systems, three cover crops and five N rates were evaluated for cotton production. The tillage systems were no-till (NT) and conventional-till (CT). The cover crops were wheat, hairy vetch and native vegetation. Each of the till x cover crop treatments was evaluated with N rates were 0, 35, 70, 105, and 140 lb/acre. Fertilizer N treatments, as 32% UAN, were injected three inches deep and 10 inches to the side of each row in late May. using a set of Yetter fertilizer coulters.

The CT treatments were disked twice in early April and again in late April. The tilled plots were then bedded with disk hippers. Just before planting, a reel and harrow bed conditioner was used for final seedbed preparation. The NT treatments with the wheat or native vegetation cover crops received an application of Roundup (glyphosate, 1.0 lb ai/acre) in early April followed by Gramoxone Extra (paraquat dichloride, 0.5 lb ai/acre) in late April. The NT treatments with the hairy vetch cover crop received two applications of Gramoxone Extra (paraquat dichloride, 0.5 lb ai/acre), one in early and one in late April.

Wheat and hairy vetch cover crops were drill-seeded at 90 and 25 lb/acre, respectively, about late October of each year. Cotton was planted in early May of each year at a seding rate of 5.5 seed/ft. of row. A mixture of Cotoran (fluometuron, 1.2 lb ai/acre) + Prowl (pendimethalin, 1.0 lb ai/acre) was broadcast for preemergence weed control.

Post emergence weed control in the conventional-till treatments consisted of cultivation in conjunction with banded applications of Cotoran (fluometuron, 0.6 lb ai/acre) plus MSMA (1.0 lb ai/acre) and Caparol (prometryn, 0.3 lb ai/acre) plus MSMA (1.0 ai/acre).

Post emergence weed control in the no-till treatment consisted of banded applications of Cotoran (fluometuron, 0.6 lb ai/acre) plus MSMA (1.0 lb ai/acre) and Caparol (prometryn, 0.3 lb ai/acre) + MSMA (1.0 lb ai/acre). All conventional and no-till treatments received applications of Bladex (cyanazine, 1.0 lb ai/acre) + MSMA (1.0 lb ai/acre) at layby in mid-July of each year. The no-till plots received one cultivation per year from 1991 through 1993 and were not cultivated from 1994 through 1996.

The test was irrigated with a linear move sprinkler irrigation system. The average amount of water applied each year was 5.6 inches. The test was defoliated in mid-September each year. The center four rows were harvested with a spindle picker in late September and early October each year.

The experimental design consisted of a split-plot in a randomized complete block design with three replications. The tillage systems were on main plots and a factorial arrangement of cover crops and N rates were on sub plots. The data were analyzed by analysis of variance and the protected LSD at P=0.05 was calculated for mean separation.

Results and Discussion

Lint Yield

The yield data are presented and discussed in this paper as short-term effects (first through 3rd years) and long-term effects (4th through 6th years).

Short-Term Effects

No-till and CT cotton lint yields were similar and no significant interactions between tillage and N rate were observed (Table 1). The optimal N rate was 70 lb/acre in both NT and CT. There was a significant effect of cover crop and the cover crop x N rate yield interaction was significant (Table 2). During the first three years, the optimal N rate for cotton following hairy vetch was 0 lb/acre; for cotton following wheat or native winter vegetation it was 70 lb/acre.

Long-Term Effects

Whereas the NT and CT cotton yields were similar during the first three years of the experiment, NT cotton lint yields were higher than CT yields during the last three years (Table 1). This suggests that no-till has progressive benefits that may not be obvious during the initial years of no-till practices. There was also a significant tillage x N rate yield interaction. Response to incremental increase in N rate was larger under NT than CT, indicating a greater efficiency of N use in NT. The long-term effects of cover crop and N rate and their interactions were similar to the short-term effects. Optimal N rate for cotton yield differed for each cover crop - 105 lb/acre following wheat, 35 lb/acre following hairy vetch and 70 lb/acre following native vegetation (Table 2). These optimal N rates for cotton following wheat and vetch were higher than during the first three years but were the same for cotton following native vegetation under both short-term and long-term tillage practices.

Plant Development

Node above white flower (NAWF) and terminal internode length (TIL) were affected by cover crop and N rate but not by tillage. A significant interaction between cover crop and N rate was observed for both variables. An N rate of 70 lb/acre optimized NAWF and TIL in all cover crop treatments (Table 3). At the lower N rates, however, cotton following vetch had greater NAWF than following the wheat or native cover crops. Thus, there was a smaller response of NAWF to N application in the vetch treatments that was similar to the lint yield response to N. All responses of NAWF and TIL were related to N availability, either as fertilizer or legume N.

Conclusions

Two tillage regimes (conventional-till and no-till), three cover crops (hairy vetch, wheat and native vegetation) and five nitrogen rates (0, 35, 70, 105 and 140 lb/acre) were evaluated for cotton production over a six-year period. In the first three years, cotton lint yields were similar in the two tillage regimes. In subsequent years, no-till produced higher yields than conventional-till.

With fertilizer N rates of 0 to 105 lb/acre, long-term cotton yields were higher following hairy vetch than following wheat or native cover crops (Fig. 1.) Fertilize N greater than 105 lb/acre increased yield of cotton following wheat, but was an excessive rate for cotton following vetch or native cover crops. Optimal N rate was not affected by tillage, although in later years of the study, fertilizer N efficiency appeared to be higher in no-till treatments. The optimal N rate varied with cover crop and was 35 lb/acre following vetch, 70 lb/acre following native and 105 lb/acre following wheat cover.

Node above white flower and terminal internode length were increased by hairy vetch and fertilizer N application and were not affected by tillage.

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Table 1. Cotton lint yield in two tillage regimes with five fertilizer N rates, averaged across three cover crops.

	Tillage regime			
	Short term[1]		Long-term[2]	
N rate	No-till	Conv.-till	No-till	Conv.-till
	---------------------------lb lint per acre-------------------------			
0	941	958	826	907
35	1089	1114	1093	1033
70	1193	1165	1274	1152
105	1164	1209	1300	1211
140	1202	1175	1250	1219
Average	1118	1125	1148	1104

LSD (0.05):
To compare tillage by N rate means within any column = 63.
To compare tillage means averaged across N rates = 36.

[1]Initial, 2nd and 3rd year of the experiment.
[2]Fourth, 5th and 6th year of the experiment.

Table 2. Cotton lint yield following three cover crops with five fertilizer N rates, averaged across two tillage regimes.

	Cover Crop					
	Short-term[1]			Long-term[2]		
N Rate	Native	Vetch	Wheat	Native	Vetch	Wheat
	-----------------------------------lb lint/acre--------------------------					
0	826	1177	847	671	1182	747
35	1090	1191	1025	998	1237	954
70	1222	1217	1099	1232	1277	1130
105	1228	1181	1152	1240	1281	1245
140	1155	1219	1194	1191	1233	1281
Average	1104	1197	1063	1066	1242	1071

LSD (0.05) Cover Crop x N rate (Short-Term) = 107
LSD (0.05) Cover Crop x N rate (Long-Term) = 70.

[1]Initial, 2nd and 3rd year of experiment.
[2]Fourth, 5th and 6th year of experiment.

Table 3. Node above white flower (NAWF) and terminal internode length (TIL) in cotton following selected winter cover crops, averaged across two tillage regimes.

N rate	-------Vetch--------		------Wheat--------		------Native---	
-lb/a-						
	NAWF	TIL	NAWF	TIL	NAWF	TIL
0	5.3	1.8	4.2	1.5	4.4	1.4
35	5.6	1.9	4.7	1.8	5.1	1.8
70	5.9	2.0	5.5	2.0	5.8	2.0
105	5.9	2.1	5.7	2.0	5.8	2.0
140	6.0	2.0	5.9	2.0	5.6	1.9
Average	5.7	1.9	5.2	1.9	5.3	1.8

LSD (0.05):
To compare cover crop x N rate means: NAWF = 0.4; TIL = 0.2
To compare cover crop means averaged across N rates: NAWF = 0.2; TIL = 0.1