Influence of Conservation Tillage Practices on Grain Yield and Nitrogen Status of Corn Grown on an Alluvial Clay in Louisiana

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INTRODUCTION

Corn *(Zea mays* L.) acreage has increased dramatically in Louisiana in recent years. Research is being conducted to better define production practices that will maximize grain yield and profitability. Rainy wet periods during late winter/early spring often delays corn planting, particularly on the more poorly-drained clay soils. Delayed planting may result in decreased yield potential, as well as lower grain prices, increased conflict with management of other crops, and higher risk from tropical storms. According to Mascagni and Boquet (1996), optimal corn planting dates range from mid-March to mid-April in north Louisiana.

Recent govemment policies involving soil conservation have increased the need for research evaluating minimum-tillage systems. One of the principal advantages of no-till (NT) systems is more timely planting, especially on the pmrly drained, clayey soils (Boquet and Coco, 1993). Herbek et al. (1986) found a tendency for corn grain yield to increase as planting date increased from late April to mid-May for the NT sysem on a poorly drained soil, while for the conventional-tillage (CT) plots, grain yields decreased with delayed planting date. Although limited tillage research on corn has been conducted in Louisiana, no-till or minimum tillage production systems for cotton *(Gossypiurn hirsutum* L.) have shown promise, when compared to the more traditional tillage practices on alluvial clays of the Mississippi River (Boquet and Coco, 1993; Crawford, 1992; Reynolds, 1990).

The inclusion of winter cover crops in combination with conservation tillage has been found to be an important component of minimum-tillage systems. The use of these systems may reduce soil erosion, especially on the sloping silt loams of the Macon Ridge (Hutchinson et al., 1991); increase soil organic matter (Boquet and Coco, 1993); reduce soil moisture evaporation (Wilhelm et al., 1986); and modify soil temperature (Wilhelm et al., 1986). The use of a leguminous cover crop, i.e. crimson clover *(Trifolium incarnatum* L.), contributes biologically fixed N (Ebelhar et al., 1984), thus reducing the N fertilizer requirement and the potential of polluting ground water with nitrate-N.

Information is needed for corn production systems that will enhance profitability and protect the environment from unnecessary pollution of soil and water. Objective of these experiments was to evaluate the influence of tillage systems, cover crops, and N rate on corn grain yield and N uptake on an alluvial clay soil.

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MATERIALS AND METHODS

Field experiments were conducted from 1994 to 1996 to evaluate the effects of tillage systems, cover crops, and N rate on corn grown on a Sharkey clay (very-fine montmorillonitic, nonacid, thermic Vertic Haplaquepts) at the Northeast Research Station near St. Joseph, LA. Tillage treatments were CT and NT. Cover crop treatments were native vegetation, crimson clover (‘Tibbee’ in 1994 and 1995 and ’Robin’ in 1996) and wheat *(Triticum aestivum* L.) (‘Florida 303’ in 1994 and 1995 and ’Buckshot 2368’ in 1996). Nitrogen rates evaluated were SO, 100, 150, and 200 lb N/a.

The experimental design was a randomized complete block with a split-plot arrangement of treatments having four replications. Tillage treatments were main plots and cover crops and N rates were factorially arranged as split plots. Plots were four rows wide (40-in. row width) and ranged from 28 to 50 A. long.

Conventional-till consisted of double-disking, bedding, and a bed smoothing operation just before planting. No-till consisted of no spring primary tillage operations. Beds were rehipped and smoothed (rolled) for planting in the fall.

Cover crops (crimson clover and wheat) were hand broadcast in 1994 and drill planted in

1995 and 19%. Seeding rates were 25 lb/a for crimson clover and 120 lb/a for wheat when broadcast and 15 lb/a for crimson clover and 90 lb/a for wheat when drilled. In 1994, beds were smoothed (rolled) immediately after seeding the cover crops.

Cover crops were burned back in early spring each year. In 1994, *two* burndown applications of 0.6 lb ai/a of paraquat plus 0.25% surfactant were applied in early to late March across all cover crop treatments. A similar rate of paraquat was applied with pre-emerge treatments. In 1995 and 1996, 0.6 lb ai/a of paraquat plus 0.5% surfactant was applied **on** the crimson clover and native vegetation and 1.0 lb ai/a of glyphosphate plus 0.5% surfactant was applied on the wheat cover crop in early to mid-March. A second application of 0.6 lb ai/a of paraquat was applied about a week later. A similar rate of paraquat was also applied with pre-emerge treatments.

Pre-emerge treatments consisted of labelled rates of alachlor or metolachlor and atrazine at each location. Post-emerge applications were 1.5 lb ai/a of linuron and 1.0 lb ai/a of atrazine plus 0.25% surfactant in 1994. In 1995, 1.0 lb ai/a of linuron and 1.0 lb ai/a of atrazine plus 0.5% surfactant was applied at layby. Insecticide treatment was 1 lb ai/a of carbofuran applied in-how in all tests.

Corn ('Pioneer hybrid 3165') was planted at about 27,000 seeds/a using a John Deere 7100 or 7300 planter. Ripple coulters, if needed were mounted on the planter for no-till planting. Planting date was 4 April in 1995, however, planting dates were different for tillage treatments in 1994 and 1996 due to inclement weather affecting the CT seedbed preparation. Planting dates were 21 March for NT and 11 April for CT in 1994 and 4 April for NT and 12 April for CT in 19%.

Nitrogen treatments were broadcast at about the four-leaf growth stage. The N source was ammonium nitrate. Whole above-ground plant samples were collected from each plot at the early silk growth stage in 1994 and 1995, and grain samples were collected from each plot in 1996. Plant and grain samples were dried, ground, and analyzed for N using Kjeldahl procedures. Nitrogen uptake was determined by multiplying the *dry* weight by plant or grain N concentration.

Corn was harvested from two center rows of each four-row plot. Grain yields were adjusted to 15.5% grain moisture. Analyses of variance of yield data were conducted using GLM prccedures of SAS. The LSD Cp4.05) was calculated for mean separation.

RESULTS AND DISCUSSION

Rainfall was well distributed at St. Joseph in 1994 and 1996, with June rainfall below the long-term mean in 1995 (2.3 in.). Averaged across all treatments grain yields ranged from 89 bu/a in 1996 to 138 bu/a in 1994 (Table 1).

Grain yields were not significantly affected by tillage treatment in any year (Table 1). Averaged across years, grain yield was 117 bu/a for the NT treatment and 114 bu/a for the CT treatment. There was a relatively large difference between tillage treatments in 19%. Mean grain yield for NT was 97 bu/a compared to 81 bu/a for CT. The lack of statistical significance (P=0.11) between tillage treatments was probably due to a high CV (19%). Although tillage treatments were confounded by planting date in 1994 and 1996, the delayed planting for the CT treatment was considered part of the treatment effect. Planting date for each of the tillage treatments were within the recommended planting window for north Louisiana (15 March to 15 April).

Grain yields were influenced by cover crop treatments each year (Table 1). Highest grain yields occurred when corn followed crimson clover and native vegetation. Grain yields were severely reduced by the wheat cover crop regardless of tillage treatment. Grain yields following wheat decreased 35% in 1994, 27% in 1995, and 23% in 1996 when compared to the other cover crop treatments. Averaged across years, grain yields for corn following wheat were decreased 30%. Although plant populations were decreased approximately 10% following wheat, this would not account for the large difference in grain yield among cover crops.

Grain yields continued to increase as N rates increased each year (Table 1). There appeared *to* be a linear yield increase up to 200 lb N/a on this clay soil. There were no significant cover crop X N rate interactions for grain yield, which indicates that the grain yield response to N rate was similar among cover crops. At an equivalent yield level, corn following wheat would require a higher N rate than for corn following crimson clover or native vegetation.

Mean N uptake for whole-plant (at early silk) in 1994 and 1995 and seed in 1996 was highest when corn followed crimson clover or native vegetation (Table 2). Similar to grain yield response, there were no significant cover crop X N rate interactions for N uptake. Nitrogen uptake increased as N rate increased each year.

The lack of a significant cover crop X N rate interaction for grain yield and N uptake indicates that crimson clover did not contribute significant amounts of plant-available N during the growing season. This was due in part to the slow growth of crimson clover in these experiments, resulting in relatively low biomass production. The N equivalent averaged less than 40 lb N/a at burndown (data not shown). Similarly, the lack of a significant cover crop **X** N rate interaction for grain yield and N uptake indicates that the reduced corn grain yield following wheat probably was not due to N fertilizer immobilization. Other factors that might influence the cover crop effect on grain yield include alleopathic effects and immobilization of the native soil N by the wheat plant.

CONCLUSIONS

Data in this 3-yr study indicate that minimum tillage systems may be equivalent to the traditional tillage systems on the alluvial clay soils in northeast Louisiana. More timely planting is better assured by using a NT management system. There was little agronomic benefit from cover crops evaluated in these studies. Crimson clover did not produce enough available plant N to influence the N fertilizer efficiency. Grain yields were reduced significantly following wheat as a cover crop. The mechanism causing this yield reduction is not clear and needs to be determined.

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Table 1. Influence of tillage, cover crop, and N rate on corn grain yield on Sharkey clay at St. Joseph, LA, for three years.

Treatment	1994	1995	1996	Mean
	--------------------	bu/a	--------------------	
Tillage				
No-till	136	119	97	117
Conventional	140	120	81	114
LSD(0.05)	NS[1]	NS	NS	NS
Cover Crops				
Native	155	131	94	127
wheat	102	95	74	90
Crimson Clover	157	131	98	129
LSD(0.05)	7	7	7	**4**
N rate, lb/a				
50	83	78	43	**68**
100	130	106	77	104
150	162	136	101	133
200	178	157	133	156
LSD(0.05)	8	9	8	9

[1]Non-significant at the 0.05 probability level.

Table 2. Influence of tillage, cover crop, and N rate on N uptake[1] on Sharkey clay at St. Joseph, LA, for three years.

Treatment	1994	1995	1996
	----------lb N/a----------		
Tillage			
No-till	122.8	107.1	43.3
Conventional	135.6	114.1	35.5
LSD(0.05)	NS[2]	NS	NS
Cover Crops			
Native	141.3	121.0	41.5
Wheat	106.8	86.8	32.3
Crimson Clover	139.4	124.2	44.1
LSD(0.05)	13.9	17.1	3.8
N rate, lb/a			
50	84.1	76.3	18.8
100	126.4	91.9	33.5
150	141.4	124.0	43.6
200	164.7	149.0	61.3
LSD(0.05)	16.1	19.7	4.4

[1]In 1994 and 1995, whole-plant N uptake at silking was measured. In 1996, *seed* N uptake was measured.
[2]Non-significant at the 0.05 probability level.