Influence of Cover Crop and Tillage on Grain Yield and Nitrogen Status of Corn Grown on a Loessial Silt Loam and Alluvial Clay in Louisiana

H.J. Mascagni, Jr., R.L. Hutchinson, D.B. Reynolds, B.R. Leonard, and D.R. Burns
Louisiana State University Agricultural Center, Northeast Research Station

Introduction

Corn acreage has increased in recent years in Louisiana. Much of this acreage is on mixed to heavy Mississippi River alluvial soils and to a lesser extent on loessial silt loams of the Macon Ridge. Each of these soil groups are unique in their physical and chemical characteristics and different management strategies may be required to produce optimal grain yield.

Recent government policies involving soil conservation has increased the need for research developing minimum tillage systems. According to Boquet and Coco (1993), one of the principal advantages of no-till systems is more timely planting, especially on the poorly drained, clayey soils. Herbek et al. (1986) found a trend for corn yield to increase as planting date increased from late April to mid-May for the no-till system on a poorly drained soil, while for the conventially tilled plots yields decreased with delayed planting date.

In a Louisiana study, Hutchinson et al. (1993) found on the Macon Ridge only small differences in corn yield among conventional-till, reduced -till, and no-till treatments. Although limited tillage research on corn has been conducted in Louisiana, no-till or minimum-tillage production systems for cotton 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) and on the Macon Ridge (Hutchinson and Shelton, 1990). The inclusion of winter cover crops in combination with conservation tillage was found to be an important component ofthe systems.

The use ofminimum-tillage systems may reduce soil erosion, especially on the sloping silt loams ofthe 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, 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. Objectives of these experiments were to evaluate the influence of tillage systems, cover crops, and N rate on corn grain yield and N uptake.

Materials and Methods

Field experiments were conducted in 1994 and 1995 to evaluate the effects of tillage systems, cover crops, and N rate on corn grown on Sharkey clay (very-fine, montmorillonitic, nonacid, thermic Vertic Haplaquepts) at the Northeast Research Station, St. Joseph, LA, and on a Gigger silt loam (fine-silty, mixed, thermic Typic Fragiudalf) at the Macon Ridge Research Station, Winnsboro, LA. Tillage treatments were conventional tillage (CT) and no-till (NT). Cover crop treatments were native vegetation, crimson clover (‘Tibbee’) and wheat (‘Florida 303’, except Winnsboro 1995- ‘Coker 9803’). Nitrogen rates evaluated were 50, 100, 150, and 200 lb NIA.

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-inch row width) and ranged from 28 to 50 feet 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. At Winnsboro, the last cultivation of cotton helped rebuild the bed and no fall tillage was performed. At St. Joseph, 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. 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. At Winnsboro, seeds were were broadcast into standing cotton stalks. After seeding, cotton stalks were cut with a rotary mower. At St. Joseph in 1994, beds were smoothed (rolled) immediately

H.J. Mascagni. Jr.. Assistant Professor. Louisiana State University Agricultural Center, Northeast Research Station, P.O. Box 438, St. Joseph. LA 71366 (Phone:3 18-766-3769; Fax:3 18-766-4278). R.L. Hutchinson. D.B. Reynolds. B.R. Leonard. and D.R. Burns. Northeast Research Station. St. Joseph. LA.

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 at both locations. A similar rate of paraquat was also applied with preemerge treatments. In 1995 at both locations, 0.6 lb ai/A ofparaquat plus 0.5% surfactant on the crimson clover and native vegetation and 1 lb ai/A of glyphosphate plus 0.5% surfactant was applied on the wheat cover crop in mid-March. A second application of 0.6 lb ai/A of gramoxone was applied about a week later St. Joseph. A similar rate of paraquat was also applied wih preemerge treatments at both locations.

Preemerge treatments consisted of labelled rates of alachlor or metolachlor and atrazine at each location. Postemerge applications were 1.5 lb ai/A of linuron and 1 lb ai/A of atrazine plus 0.25% surfactant at St. Joseph in 1994. In 1995 at St. Joseph, 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-furrow in all tests.

Corn ('Pioneer 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. At Winnsboro, planting dates were April 8 in 1994 and April 5 in 1995. At St. Joseph in 1995, planting date was April 4; however, planting dates were different for the different tillage treatments in 1994 due to inclement weather affecting the CT seedbed preparation. Planting dates were March 21 for NT and April 11 for CT.

Nitrogen treatments were broadcast at about the four-leaf growth stage. Nitrogen source was ammonium nitrate. Whole above-ground plant samples were taken from each plot at the early silk growth stage each year. Plants were dried, ground, and analyzed for N using Kjeldahl procedures. Nitrogen uptake was determined by multiplying the total dry weight at early silk by plant 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 procedures of SAS. The LSD (P=0.05) was calculated for mean separation.

Results and Discussion

Grain yields were not affected by tillage in any of the experiments (Tables 1 and 2). Although tillage treatments were confounded by planting date in 1994, the delayed planting for the CT treatment was considered part of the treatment effect. Rainfall distribution was excellent throughout the 1994 growing season. Planting date for NT (March 21) and CT (April 11) were within the recommended planting window for north Louisiana (March 15 to April 15).

Grain yields were influenced by cover crops each year at St. Joseph (Table I). Highest grain yields occurred when corn followed crimson clover and native vegetation. At St. Joseph, corn growth was severely reduced by the wheat cover crop treatments regardless of tillage treatment (Table I). Yields following wheat were decreased 24% in 1994 and 29% in 1995. Although plant populations were decreased approximately 10%following wheat, this would not account for the large differences in grain yield among cover crops.

Averaged across cover crops, yields continued to increase as N rates increased at St. Joseph each year and Winnsboro in 1995(Table I). In 1995 at Winnsboro, maximum yield occurred at 150 lb N/A. There were no significant cover crop X N rate interactions for yield, which indicates that the yield response to N rate was similar among cover crops. This is illustrated in Figs. 1 and 2 for the St. Joseph location. The increase in yield as N rates increased was very similar among cover crop treatments.

Averaged across cover crops, whole-plant N uptake at early silk continued to increase as N rates increased at St. Joseph each year, while at Winnsboro maximum N uptake occurred at 150 lb N/A (Table 2). Similar to yield response, there were no significant cover crop X N rate interactions for N uptake. At St. Joseph, the rate of N uptake was similar among cover crop treatments (Figs. 3 and 4). Nitrogen uptake ranged from 66 to 175 lb N/A in 1994 and 53 to I75 lb N/A in 1995.

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

Conclusions

Preliminary data indicate that minimum tillage systems may be equivalent to the traditional tillage systems on the alluvial clay soils and the loessial silt loam soils of northeast Louisiana. There was little agronomic benefit from cover crops in these studies. Crimson clover did not produce enough biomass and plant N for corn production systems in northeast Louisiana. Corn yield was reduced following wheat, particularly on the alluvial clay soil. The mechanism causing this yield reduction is not clear and needs to be determined.

Table 1. Influence of tillage, cover crop, and N rate on corn grain yield at St. Joseph and Winnsboro in 1994 and 1995.

	St. Joseph		Winnsb...	
Treatment	1994	1995	1994	1995
	bu/acre			
Tillage[1]				
No-till	136	119	129	99
Conventional	140	120	128	107
LSD(0.05)	NS	NS	NS	NS
Cover Crops				
Native	155	131	127	108
Wheat	102	95	124	99
Crimson Clover	157	131	134	104
LSD (0.05)	7	7	6	NS
N rate, lbs/acre				
50	83	78	104	79
100	130	106	129	105
150	162	136	141	109
200	178	157	141	120
LSD (0.05)	8	9	10	11

NS = Nonsignificant at the 0.05 probability level.
'No-till and conventional planted on March 21 and April 11, 1994, respectively.

Table 2. Influence of tillage, cover crop, and N rate on total plant N uptake at early silking at St. Joseph and Winnsboro in 1994 and 1995.

	St. Joseph		Winnsboro	
Treatment	1994	1995	1994	1995
	lbs N/acre			
Tillage[1]				
No-till	123	107	113	117
Conventional	136	114	106	120
LSD(0.05)	NS	NS	NS	NS
Cover Crops				
Native	141	121	104	122
Wheat	107	87	108	116
Crimson Clover	139	124	118	117
LSD(0.05)	14	17	NS	NS
N rate, lbs/acre				
50	84	76	76	95
100	126	92	109	111
150	141	124	126	130
200	165	149	130	138
LSD (0.05)	16	20	16	13

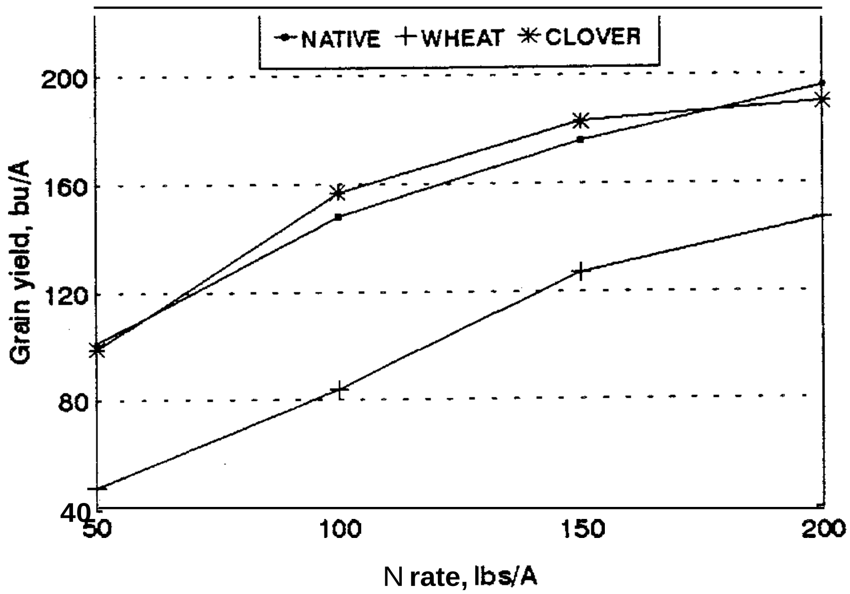


Figure 1. Influence of cover crop, and N rate on grain yield averaged across tillage treatments at St. Joseph in 1994.

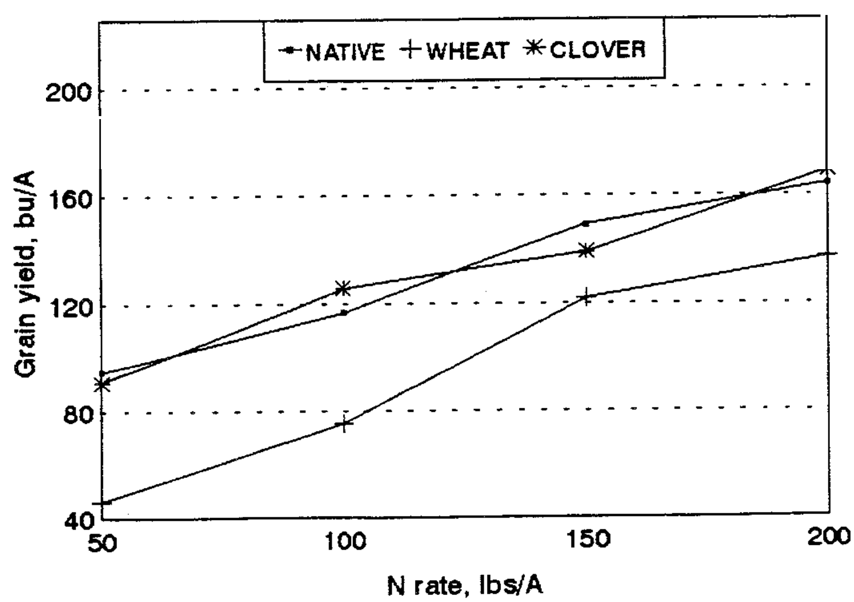
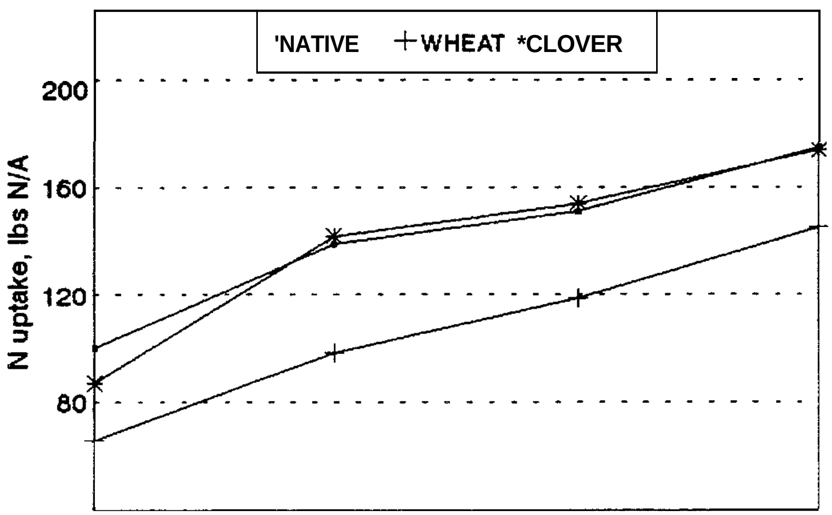


Figure 2. Influence of *cover* crop, and N rate on grain yield averaged across tillage treatments at St. Joseph in 1995.



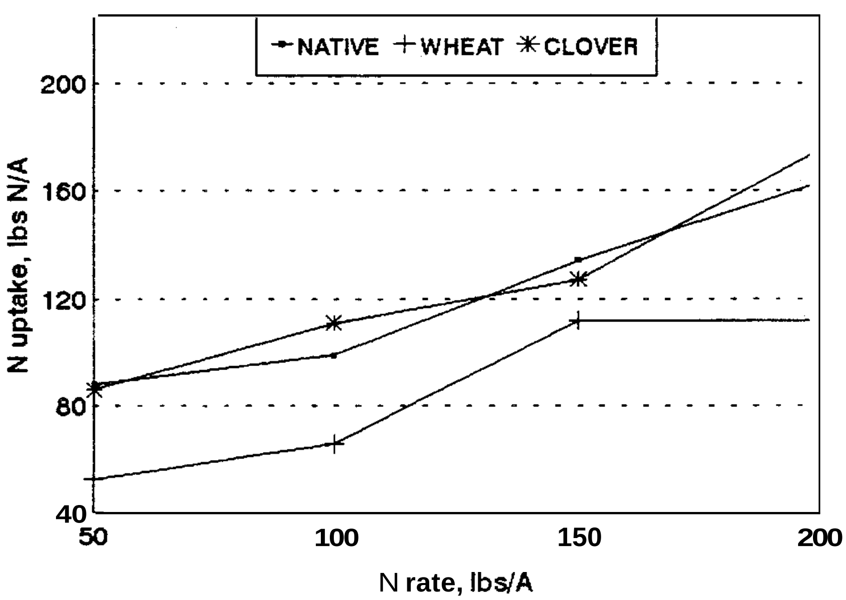


Figure 4. Influence of cover crop, and N rate on total N uptake at early silking averaged across tillage treatments at St. Joseph in 1995.

Literature Cited

Boquet, D.J., and A.B. Coco. 1993. Cotton yield and growth responses to tillage and cover crops on Sharkey clay. p. 100-105. In Proc. 1993 Southern Conservation Tillage Conference for Sustainable Agriculture, Monroe, LA 15-17 June 1993. LA Agric. Exp. Stn. Baton Rouge, LA.

Crawford, S.H. 1992. Preplant weed control in conservation tillage systems for cotton. p. 139-140. In Proc. Beltwide Cotton Prod. Conf. 6-10 June, 1992. Nashville, TN. National Cotton Council of Amer. Memphis, TN.

Ebelhar, S.A., W.W. Frye, and R.L. Blevins. 1984. Nitrogen from legume cover crops for no-till corn. Agron. J. 76:51-55.

Herbek, J.H., L.W. Murdock, and R.L. Blevins. 1986. Tillage systems and date of planting effects on yield of corn on soils with restricted drainage, Agric. J. 78:824-826.

Hutchinson, R.L., R.E.A. Brown, B.R. Leonard, K.W. Paxton, and T.J. Riley. 1993. Alternative tillage systems and in-furrow insecticide for profitable corn production. LA Agric. 37(2):23-25.

Hutchinson, R.L., R.C. Aycock, C.P. Boquet, S.M. Cruse, P.A. Mitello, C.L. Pinnel-Alison, R.L. Rogers, and W.W. Russell. 1991. An evaluation of conservation tillage systems for cotton on the Macon Ridge. LA Coop. Ext. Serv. Pub. 2460.

Hutchinson, R.L., and W.L. Shelton. 1990. Alternative tillage systems and cover crops for cotton production on the Macon Ridge. LA Agric. 33(4):6-8.

Reynolds, D. 1990. Evaluation of bumdown and residual herbicides for soybeans planted into a stale seedbed. p. 341-347. In Northeast Res. Stn. Ann. Prog. Rep. LA Agric. Exp. Stn. Baton Rouge, LA.

Wilhelm, W.W., J.W. Doran, and J.F. Power. 1986. Corn and sorghum yield response to crop residue management under no-tillage production systems. Agron. J. 78:184-189.