SOIL/WATER RESEARCH
South Dakota State University
2008 Progress Report

Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007

Nitrogen Rates for Corn as Affected by Rotation and Residue (36708)

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Introduction

Nitrogen rates for corn are receiving renewed attention because of high nitrogen fertilizer prices. Environmental concerns with nitrate-N leaching, hypoxia in the Gulf, and the Conservation Security Program (CSP), are also having an impact in renewing questions about nitrogen rates for corn.

Much of the recent work for corn N rates has been on corn following soybean. However, more corn on corn rotations are also being used because of favorable economics with this rotation. Little N calibration work has been done on corn following low residue, non-legume crops such as corn silage or sunflower. In theory, N rate needed for maximum economic corn yield may be less following these crops than following a high residue corn or small grain crop. Less N may be immobilized because of lower residue amounts that contain high C:N ratios.

The nitrogen rate for corn following soybean has always been found to be lower than for corn following corn. This so called 'nitrogen credit' given for soybean is actually a misnomer. It implies that the soybean crop has provided 40 lbs of N in the soil for the corn crop. In reality it means that corn grown after soybean takes less N for maximum yield than corn following corn or following another high residue crop. The extra N needed for the corn after corn is probably needed for the microbes breaking down the low N residue. In fact, we should probably base our N rates for corn when it follows soybean and add another 40 lbs for corn following a high residue crop. Much like we add another 30 lb N/a if the tillage system is no-till or strip-till.

Our objectives in this study are:

1) to determine the maximum economic N rate for:

a) corn following soybean

b) corn following corn

c) corn following corn (above ground residues removed CC_{rr}).

2) to measure and compare soil nitrate-N, total soil N and total soil carbon after each of the above rotations and N treatments.

Methods

A tilled site was established on the north quarter of the Southeast Research Farm near Beresford (SERF) in the spring of 2005 to answer the above objectives. The site consists of Egan silty clay loam soils which are deep well drained soils found in glacial till. The slope is from 2-3%. Beginning soil tests are OM % = 3.5, P ppm=13, K ppm=301, Zn ppm=1.4, Sulfate-S lb/a in 2'=46, pH=7.2 and salts=0.8 mmho/cm. All nutrients are high to very high levels. The beginning 2008 soil nitrate-N values after soybean ranged from 40 to 70 lb/a in 2 feet.

Nitrogen treatments are 0, 30, 60, 90, 120, 150, and 180 lb N/a as urea. The N rates were applied only on the corn / soybean (CS) rotation because drought condition in 2007 restricted corn yields resulting in large amounts of carry-over N in the corn / corn (CC) and the corn / corn residue removal (CCRR) rotations. The experimental design is a split-strip with four replications. The N rates are the splits within each rotation strip. Plot size is 15 by 50 feet. The urea was broadcast with a Gandy air applicator on April 17. The field was disked and field cultivated within a day of urea application.

Corn (Dekalb DK 58-16) was planted at 30,000 seeds/ac on April 23, 2008. Weeds were controlled as needed. Ear leaf samples were obtained for N concentration analysis on July 25, 2008 (initial silk). Grain was harvested in the

four center rows, each 45 foot in length with a plot combine. Four soil cores were sampled in 0-6, 6-12, and 12-24 inch increments and composited by depth on Nov 1. Stalks were chopped, raked and baled on the low residue strips. No fall tillage was done.

Results

The drought in 2007 severely reduced corn yields and therefore high levels of residual soil nitrate-N were present for the 2008 crop for the CC and CCrr rotations. Therefore, no fertilizer nitrogen was applied to these rotations in 2008.

Ear leaf total N (%) was significantly influenced by applied N rate for the CS rotation and the residual N (Table 1) left by N rate applications made in 2007 for the CC and CCrr rotations. (Table 2). Although there is some variability, leaf N concentrations reach a maximum at approximately 120 lbs N/a added N rate for the CS rotation and for the 120 lbs N/a residual level for the CCrr rotation. However, with the CC rotation (with residue) corn leaves do not reach a maximum N concentration until the 180 lbs N/a residual level. Fair correlations of ear leaf N and grain yield were evident (Figure 1).

Grain yields were significantly influenced by N rate and rotation (Table 3). In the CS rotation grain yield was maximized with 150 lbs N/a rate. Grain yield was also increased with residual N carryover by the previous N rate applied in 2007 for the CC and CCrr rotations. However, grain yield was not as high as with the CS rotation. Soil test nitrate-N levels (STN) in the CC and CCrr rotations were higher than the STN plus fertilizer N application levels and still did not produce similar grain yields (Figure 2). Similar to previous years, nitrogen was not the limitation to plant growth and yields here. Our speculation is that some of the grain yield reductions are due to alleopathy from the rotation of corn following corn.

Soil test nitrate-N levels (STN) for November 2008 were significantly influenced by N fertilizer rate (Table 3). This influence was even evident for the CC and CCrr rotations that hadn't received fertilizer N since April 2007. These STN levels are low enough that fertilizer N rate applications will be made for the 2009 crop year.

Summary and Conclusions

Very high residual soil test nitrate-N levels caused by the drought during 2007 for the CC and CCrr rotations prevented fertilizer N rate applications to these rotational plots.

Ear leaf total N concentrations were significantly influenced by N rate (CS rotation) and residual STN levels for the CC and CCrr rotations.

Grain yield was significantly influenced by applied N rate for the CS rotation and residual STN for the CC and CCrr rotations.

The CS rotation grain yields were higher when compared to the CC and CCrr rotations even though higher amounts of N (Fertilizer N + STN) were available to these plots.

Acknowledgment

This project partially funded by the SDSU soil testing lab, and the SE South Dakota Research Farm. Also, we would like to thank the SE Research Farm Staff for their dedication and help.

Table 1. Influence of N rate, crop rotation and residue removal on residual soil nitrate-N, Beresford SD, Nov 1, 2007.

N Rate	------- Rotation/residue ----- CS[1]	CC[2]	CC_{rr}[3]
	---------- nitrate-N, lb/a in 3 feet [4] ----------		
0	52	58	71
30	52	63	63
60	51	75	89
90	54	99	121
120	43	170	146
150	54	140	227
180	68	226	232

[1] CS = corn after soybean (samples from 2007 soybean plots)
[2] CC = corn after corn
[3] CC_{rr} = corn after corn, residue removed
[4] sampled Oct. 25 2007.

Table 2. Influence of N rate, crop rotation and residue removal on ear leaf total N, Beresford SD, 2008.

N Rate	------- Rotation/residue ----- CS[1]	CC[2]	CC_{rr}[3]	**Mean**
	---------- Total N (%) ----------			
0	1.69	1.84	1.96	**1.83**
30	1.91	1.85	2.09	**1.95**
60	2.06	2.04	2.13	**2.07**
90	2.37	2.06	2.32	**2.25**
120	2.74	2.24	2.60	**2.53**
150	2.84	2.42	2.29	**2.52**
180	2.76	2.79	2.83	**2.79**
Mean	**2.34**	**2.18**	**2.32**	
Stats	CV=10.2%. Pr>F: rate=0.001, rot. = 0.267, rate x rot. = 0.063			

[1] CS = corn after soybean
[2] CC = corn after corn
[3] CC_{rr} = corn after corn, residue removed
The CC and CCrr rotations did not get N rate application for 2008 because of very high residual N carryover from 2007 (see Table 1).

Table 3. Influence of N rate, crop rotation and residue removal on corn grain yields and residual soil nitrate-N, Beresford SD, 2008.

N Rate	------- Rotation/residue -----			
	CS[1]	CC[2]	CC_{rr}[3]	**Mean**
	---------- corn grain yield, bu/a ----------			
0	88.7	82.2	85.7	**85.5**
30	107.3	84.6	89.9	**93.9**
60	125.2	85.2	84.5	**98.3**
90	138.3	93.4	104.1	**112.0**
120	142.3	109.2	106.5	**119.3**
150	167.2	106.6	120.0	**131.2**
180	156.9	118.6	137.1	**137.6**
Mean	**132.3**	**97.1**	**104**	
Stats	CV=10.2%. Pr>F: rate = 0.001, rot. = 0.003, rate x rot. = 0.005			
	---------- nitrate-N, lb/a in 2 feet [4]----------			
0	14	16	16	**16**
30	17	17	21	**18**
60	19	21	20	**20**
90	24	18	18	**20**
120	22	23	27	**24**
150	24	26	26	**25**
180	26	25	26	**26**
Mean	**20.7**	**20.9**	**22.0**	
Stats	CV=20.6%. Pr>F: rate = 0.02, rot. = 0.74, rate x rot. = 0.53			

[1] CS = corn after soybean
[2] CC = corn after corn
[3] CC_{rr} = corn after corn, residue removed
[4] sampled Nov 1, 2008.
The CC and CCrr rotations did not get N rate application for 2008 because of very high residual N carryover from 2007 (see Table 1).

Figure 1. Ear leaf N concentration and crop rotation influence on corn grain yield, SE Farm, 2008.

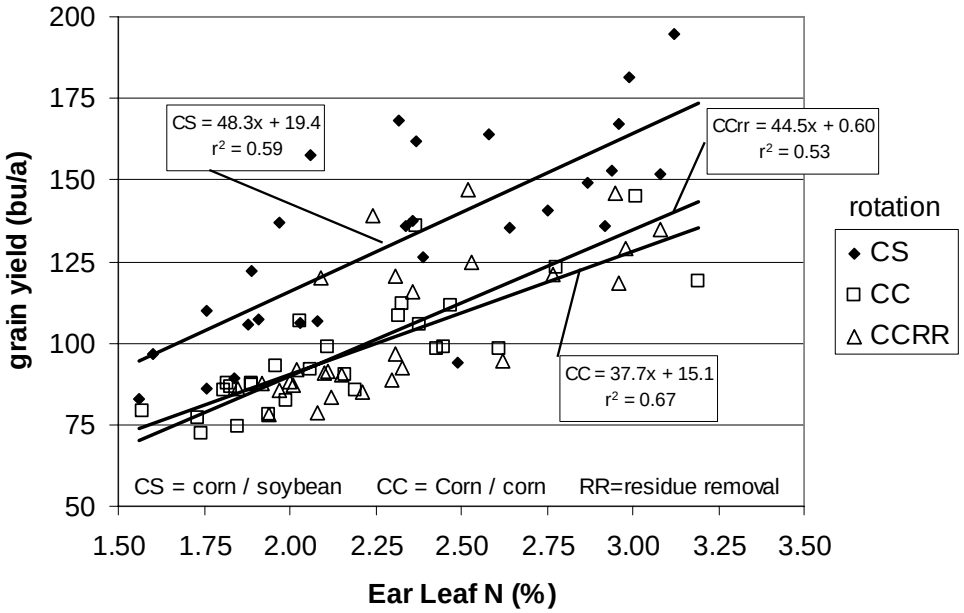

Figure 2. Fertilizer N + Soil Test Nitrate-N and crop rotation influence on corn grain yield, SE farm, 2008.