RESPONSE OF CORN TO N FERTILIZATION IN FALL, SPRING AND (OR) SUMMER

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Abstract

Precision farming technologies (remote sensing of canopy reflectance and yield monitoring) were used to study the response of corn after soybean to fertilizer N applied at different times in three field-scale trials in central Iowa in 1999. Weather conditions were unusually favorable for losses of fall-applied N and crop responses to N indicated that substantial losses occurred. Yields of corn could be maintained by adding a nitrification inhibitor or additional N, but the greatest profit was attained by applying 100 lb N/acre at V6. Fertilization as late as stage R1 increased yields in situations where large losses of N resulted in severe N deficiencies.

Introduction

Nitrogen fertilizer recommendations have focused more on rate of application than on methods and times of application. Many recommendations, for example, call for the same rates whether N is applied in the fall, in early spring before planting, or after plants have grown to heights of several inches. Such recommendations essentially ignore evidence that spring rainfall can result in substantial losses of fertilizer N. These losses have been easy to ignore because they are not easily detected.

The use of precision farming technologies (Blackmer and White, 1998) in field-scale trials during the past few years has provided compelling evidence for large losses of fall-applied N in many fields (White and Blackmer, 1997; Lane, 2000). The trials involved applying extra N in strips to fields that were fertilized the previous fall. The rates applied in the fall were high enough to maximize yields if the N had been applied after plants were several inches tall. Crop responses to extra N were measured by remote sensing of canopy reflectance and yield monitoring. These techniques reveal spatial patterns in crop responses in fields and, therefore, indicate where extra fertilizer was needed and where it was not needed.

Here we describe studies that use the same precision farming technologies to compare the effects of fertilizer N applied in the fall and in the spring after plants are several inches tall. The benefits of using N-Serve with the fall-applied N are evaluated. Also evaluated are the possible benefits of applying N during the summer (at R1) to minimize yield loss resulting from N deficiencies due to N losses.

Approach

Three sites, at least 50 acres in size, were selected in central Iowa during the fall of 1998. Each field was in a corn-soybean rotation using no-till practices. Nitrogen treatments of 125 lb N/acre were applied with and with out N-Serve in 20 ft swaths going the length of the field during

November of 1998. Forty-foot swaths without N were left between swaths with N. However. P and K were applied to the entire field with the same applicator to a depth of 8-10 inches. The P fertilizer contained about 25 lb of N. All treatments were replicated at least four times at each site. In the spring each applicator swath was divided into strips the width of the combine (6 rows).

Corn was planted in the bands made by the fall application. When the corn was 6-12 inches tall, rates of 50, 100 and 150 lb of N/acre were side-dressed in 6-row strips where no fall N had been applied. At R1 an additional 75 lb of N/acre was applied to 6 of the 12 rows from each treatment that received fall N.

Color aerial photos were acquired three times through the season (July 4, August 6 and 27). Yield data was collected using an on-the-go yield monitor connected to a GPS receiver. Grain samples were collected from the combine bin for each treatment strip.

Aerial images were digitized, georeferenced using Erdas Imagine and analyzed using Arcview and Spatial Analyst. Yields were imported to Arcview. Grain samples were analyzed at the Iowa Grain Quality Lab using standard NIR techniques.

Results

A key finding is that treatment mean yields across all sites fell within a relatively narrow range. from 152 to 169 bushels/acre. Application of only 50 lb N/acre at V6 resulted in mean yields that were 90% of the highest treatment mean. Application of only 100 lb N/acre at V6 resulted in yields that were 98% of the highest treatment mean. These observations suggest that yields were essentially maximized with less N than normally recommended. These observations support the results of many other precision farming trials indicating that yields of corn after soybean usually are maximized by applying 100 lb N/acre applied after plants are six inches tall (White and Blackmer, 1999).

Because yield differences were relatively small, meaningful discussions of differences between treatments must consider treatment costs as well as yields attained. When normal costs for 1999 are considered, application of 100 lb N/acre at V6 resulted in the greatest profit (Table 1). Application of 150 lb N/acre at V6 resulted in almost the same profit.

Application of 125 lb N/acre in the fall resulted in low yields and low profits. Additions of N-Serve or extra N at R1 increased yields and profits. These yield increases can be explained only by losses of large percentages of the fall-applied N. Much of this N undoubtedly found its way to ground or surface water supplies and, therefore, adds real costs not estimated in this report.

Although N-Serve and extra N at R1 increased yields and profits, higher profits were obtained by merely applying 100 lb N/acre at V6. Although N-Serve reduced losses of N, substantial losses of N still occurred with the N-Serve this year. If it is recognized that N-Serve would not be profitable on years where losses of N are minimal, fertilization at V6 would have a clear advantage over fall N plus N-Serve. Fertilization at R1 deserves attention because it can be selectively applied on the basis of need created by weather in the first half of the growing season.

Data provided by remote sensing of canopy reflectance and analysis of grain samples showed remarkable agreement with the yield data. Although extra N has no effect on reflectance, deficiencies of N are indicated by higher relative reflectance values than found with adequate N. Deficiencies of N cause low concentrations of protein in grain, but extra N has a negligible effect on grain protein concentrations (Cerrato and Blackmer, 1990).

Yield monitoring and remote sensing of canopy reflectance offers the advantage of identifying spatial patterns in N response. Some spatial patterns were observed and they are being analyzed.

Conclusions

The results clearly indicate that fall applications of N resulted in large losses of N to the environment. For this reason, fertilization at V6 required less N to maximize yields and resulted in higher profits. Fertilization during the summer deserves more attention as a practical way to address problems associated with variability in rainfall amounts early in the season.

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Table 1. Effects of various N treatments on yield, grain protein, relative reflectance and net value of crop in three field scale strip-plot trials.

Site	Treatment, growth stage	Yield	Protein	Relative Reflectance[a]	Net value of crop[b] $1.50	$2.00	$2.50
		bu/ac	%			$/ac	
Ogden	50 lb N, V6-V8	144.5	5.9	1.03	203	276	348
	100 lb N, V6-V8	164.9	6.5	1.00	226	309	391
	150 lb N, V6-V8	168.7	6.9	0.98	225	309	393
	125 lb N, +N-Serve, Fall	161.9	6.4	0.99	211	292	373
	125 lb N, Fall	147.0	6.3	1.04	196	269	343
	125 lb N, +N-Serve, Fall; 75 lb N, R1	161.2	6.5	0.99	192	273	354
	125 lb N, Fall; 75 lb N, R1	158.1	6.9	1.01	195	274	353
Jefferson	50 lb N, V6-V8	128.9	5.7	1.04	180	244	309
	100 lb N, V6-V8	141.1	6.1	1.00	191	261	332
	150 lb N, V6-V8	143.3	6.4	0.98	186	258	330
	125 lb N, +N-Serve, Fall	143.7	6.1	0.99	183	255	327
	125 lb N, Fall	141.9	5.7	1.03	188	259	330
	125 lb N, +N-Serve, Fall; 75 lb N, R1	159.6	6.3	0.96	190	270	350
	125 lb N, Fall; 75 lb N, R1	159.5	6.3	0.97	197	277	357
Boone	50 lb N, V6-V8	173.4	4.7	1.00	247	333	420
	100 lb N, V6-V8	179.1	6.3	1.00	248	337	427
	150 lb N, V6-V8	183.9	5.6	1.00	247	339	431
	125 lb N, +N-Serve, Fall	184.2	5.3	1.00	244	336	428
	125 lb N, Fall	175.2	6.5	1.00	238	326	413
	125 lb N, +N-Serve, Fall; 75 lb N, R1	181.1	5.4	1.00	222	313	403
	125 lb N, Fall; 75 lb N, R1	177.9	6.2	1.00	225	314	403
Mean	50 lb N, V6-V8	152.0	5.9	1.02	215	291	367
	100 lb N, V6-V8	165.1	6.3	1.00	227	309	392
	150 lb N, V6-V8	169.0	6.6	0.99	225	310	394
	125 lb N, +N-Serve, Fall	166.8	6.2	0.99	218	301	385
	125 lb N, Fall	157.4	6.1	1.02	211	290	369
	125 lb N, +N-Serve, Fall; 75 lb N, R1	169.0	6.4	0.98	204	289	373
	125 lb N, Fall; 75 lb N, R1	166.6	6.4	1.00	208	291	375

[a]Relative reflectance is calculated by dividing the reflectance value of each treatment by the reflectance value of the 100 lbs N/acre sidedress treatment.

[b]Net value of crop = the value of the crop at the prices indicated after fertilization costs are subtracted. The costs assumed in the calculations were $0.15/lb for N, $7.50/acre for N-Serve, and $6.00/acre for each application of fertilizer.

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