Corn Yield Response to Nitrogen, Phosphorous and Potassium (with Sulfur) After Winter Rye

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Objective

To determine the effects of nitrogen rates on corn yields and determine the effects of the addition of phosphorous and potassium to with a standard nitrogen application to corn yields. To investigate the usefulness of currently available soil tests, tissue tests, and crop removal rates to measure soil nitrogen availability.

Background

Crop Year:	2016	Tillage:	No-till
Location:	Zanesville, OH	Baseline soils:	pH 6.4
County/Town:	Muskingum County		P 20 ppm M3
Soil Type:	Zanesville Silt Loam, 3 to 8% slope		K 59 ppm M3
		Planting Date:	24 May
Drainage:	Non systematic	Nitrogen:	28-0-0
Previous Crop:	Soybean	Seeding Rate:	34,000
		Harvest Date:	22 Nov

Methods

Five nitrogen (28-0-0) rates and three rates of phosphorus (10-30-0) or potassium with sulfur (0-0-25-17S) were planted in a randomized complete block design with three replications. Five pounds of nitrogen was applied through the planter and the remaining was sidedressed on 26 Jun. Phosphorous and potassium with sulfur were applied at sidedress. Plots were planted in 12 rows at 30 inch spacing and harvested with a commercial combine. Plots were field length at approximately 1,000 feet and individually measured for yield calculations. 0 treatment plots were only 100 feet in length. Yields were measured with a grain cart and corrected to 15% moisture. Weed control and rye termination was managed with a preplant Corvus/Atrazine/Dicamba/Glyphosate system. Soil samples, NDVI ratings, and stalk nitrate samples were collected in all plots.

Preplant soil samples, grain samples, and tissue samples were collected and submitted to a laboratory for analysis. Five twelve-inch cores were collected in each plot for composite soil samples for soil nitrogen tests. Starting nitrogen (soil test) and applied nitrogen was subtracted from nitrogen removed (grain and stover) as a projection of nitrogen that would be present at the end of the season. This was compared to a post-harvest soil nitrogen test (soil test value minus projected value). This compares the projected nitrogen estimate that would be excess in the soil after harvest to an actual laboratory estimate of soil nitrogen test after harvest.

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Results

Table 1. Corn yield and budget projections for rates of nitrogen, phosphorus, and potassium

Treatment (Total lbs N/ac)	Yield[z] (bushels/acre)	Applied Nitrogen Use (lb N/bu)[y]	Return after N[x]	Post-season plant available N (lbs)[w]
0 N	86.5 D	--	$ 302.58	113.7
100 N	183.1 AB	0.5	$ 595.92	144.5
150 N	199.6 A	0.8	$ 631.06	164.8
200 N	193.2 AB	1.0	$ 585.13	88.9
250 N	197.6 AB	1.3	$ 579.12	67.6
0 P, + K, +S, 130 N	180.0 ABC	--	--	109.4
+ P, 0 K, 0 S, 130 N	178.2 BC	--	--	96.8
0 P, 0 K, 0 S, 130 N	160.5 C	--	--	84.8

[z] Overall Mean: 172.3 bu/a; LSD (P<0.05): 20.5
[y]Applied nitrogen divided by final yield
[x]Corn at $3.50 and nitrogen at $0.45
[w]Accounts for applied nitrogen, grain/stover removal, and pre- /post-harvest soil nitrogen test.

Table 2. Laboratory test results for corn R1 ear leaf samples, stalk nitrate test samples, and grain samples collected at harvest on plots treated with different rates of nitrogen[z].

Nitrogen Rate	R1 Ear Leaf Percent Nitrogen[y]	Average Corn Stalk Nitrate (ppm Nitrate-N)	Average Grain Percent Nitrogen
0 N	2.4 A	189.3	1.2
100 N	3.7 B	44.7	1.3
150 N	4.0 B	704.3	1.4
200 N	4.0 B	1381.7	1.3
250 N	3.9 B	1372.3	1.4

[z]Ear samples were collected on 4 Aug, stalk nitrate samples were collected on 25 Oct, and grain nutrients were collected on 22 Nov.
[y]LSD (P<0.05): 0.4

Summary

The 2016 growing season in Muskingum County was characterized by above normal rainfall in April that delayed planting and below normal rainfall for the rest of the season. Total rainfall from 1 Apr to 30 Sep was 17.46 in, which is 4.24 in below normal for the time period (Zanesville Municipal Airport, USW00093824). Application rates of nitrogen were not significantly different with the exception of the 0 rate. Applications of phosphorous and potassium were not significantly different (Table 1). The application of 0 P, 0 K, 130 N showed more variability in yield results across replications than all other treatments (highest standard deviation with the exception of the 0 fertilizer treatment treatment). Under these field conditions lower rates of nitrogen were adequate for the growing season, however multi-year testing should be used to determine appropriate N rates that would account for patterns of higher rainfall and other environmental variability.

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The calculation on post-season plant available nitrogen (lbs) was completed as an estimate of nitrogen still available after harvest and to reflect mineralization by the plant (Table 1). Statistics processed on the calculated result returned P=0.0551 ($P<0.05$) with a mean of 108.8 lb N. This information was of interest in addressing the question if more soil mineralization was occurring in plots with lower rates of nitrogen than in plots with higher rates of nitrogen. This data appears to come near to a trend but requires additional replication and multi-year data collection to be more conclusive.

Corn ear leaf tissues samples, stalk nitrate samples, and grain samples are reported in Table 2 on treatments with varying rates of nitrogen. Of these samples, only R1 ear leaf tissue samples resulted in a statistically significant ($P<0.05$) response with only the 0 nitrogen rate resulting in a difference compared to other treatments. While a difference may initially appear to be present in corn stalk nitrate sample averages, the variation between plots of the same treatment was very wide.

This is useful information for evaluating fertilizer use in agronomic fields. However, it is recommended that producers examining these questions consider separating future trials into two tests where in this example nitrogen strips would be isolated from phosphorous and potassium strips in order to make interpretation easier in addressing nutrient specific questions.

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