

Corn and Soil Test Response to By-Product Nitrogen Sources

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Introduction

Bio-fermentation industries generate large volumes of nitrogen (N) rich by-products that are alternative N sources. Two such by-products are Heartland Lysine Fertilizer (HLF) and ProteFerm (ProF). Each contains organic N from microbial biomass and inorganic N from anhydrous ammonia combined with chloride or sulfate, respectively. Biomass is the remains of micro organisms that produced the amino acid. Both by-products contain approximately 6.5 to 7% total N. ProF possesses about 12 to 13% chloride (Cl) while HLF has about 5% sulfur (S) as sulfate (SO₄).

Material and Methods

A Pioneer 34A20 corn test crop received 150 lb of N/acre derived from mixtures of solution urea ammonium nitrate (UAN - 28 % N) fertilizer mixed with HLF or ProF. One-sixth, one-third, or two-thirds of the N of the 150 lb of N/acre would be supplied by HLF or ProF. The one-third of the N from ProF and HFL would provide 113 and 35 lb/acre of Cl and S, respectively. These treatments were applied broadcast on May 15 and 16 over corn plants (2 to 4 in. tall). All treatments were replicated four times. Soil samples were taken on June 14 to a depth of 10 in. from all plots when corn plants were 12 in. tall. Conventional soil tests and tests for Cl and S were also conducted on these samples. Corn leaves were collected at silking for determination of total N and macro-and micro-nutrient contents. Harvested was mid-October when corn stalk samples were collected.

Results and Discussion

Table 1 presents soil test data for samples collected when corn plants were 1 ft tall or the *Late-spring nitrate test*. Soil in the test area was slightly acid. Electrical conductivity (EC) as

measured in a 1:1 soil to water paste increased with increasing amounts of either Cl or SO₄-S from ProF or HLF, respectively. Ammonium (NH₄⁺) contents at this time were greater with the addition of N from either ProF or HLF. Generally, inclusion of either Cl or SO₄-S will retard NH₄⁺ nitrification. Nitrification is the biologically facilitated conversion of NH₄⁺ to nitrate (NO₃⁻). P and K values for the site were low or just adequate which indicates a need for their application in the next crop cycle. SO₄-S soil test data measures only the inorganic form of S. Generally, a greater portion of S resides in the organic matter of soil. Cl data showed a marked increase with the increasing amount of N supplied from ProF. Neither the Cl or SO₄-S soil test values would be considered excessive for corn grown in Iowa.

Corn leaf N content, harvest, and stalk data are presented in Table 2. At silking, corn leaf analysis indicated N levels were generally adequate. Grain moisture content in ProF treatments were slightly greater compared with 100% UAN or any of the HLF treatments. Corn yields in 2007 were very good because of adequate and timely precipitation. The greatest yield occurred where 100% of N was applied as UAN. The lowest average treatment yield occurred where 226 lb of Cl was applied with ProF-N. From the stalk N data, there is no interpretation for NH₄ but NO₃ levels indicated that amounts observed in this study were below the optimum range of 700 to 2,000 mg kg⁻¹. Inorganic P, Cl and SO₄-S were also measured in the stalk tissue. Levels of P and Cl often increase when N-deficiency is encountered. Cl increased greatly up to the 113-lb application that accompanied 50 lb of N from ProF. No normal levels of Cl have been reported in corn stalk tissue. Although stalk SO₄-S increases with its application, SO₄-S does not fluctuate as markedly in stalks.

Conclusions

This study demonstrated that by-product N from bio-fermentation industries can be beneficially used in corn production. Both Cl and SO₄-S sources will acidify soils approximately twice as fast/lb of N applied compared with other commonly used sources. To determine if Cl or S is needed is difficult as no soil tests have been calibrated for making recommendations in Iowa. Experience in neighboring states suggest that light-textured, low organic matter soil will benefit from S. The same may be said for Cl.

Unlike S, Cl application rates should not exceed 50 lb/acre. Either HLF or ProF can be combined with UAN to deliver appropriate amounts of S and Cl.

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Table 1. Soil test responses from 150 lb of N using various portions of by-product N.

150 lb N % N from source	pH	Electrical conductivity dS cm ⁻¹	NH ₄ -N	NO ₃ -N	Bray1-P	K	SO ₄ -S ^a	Cl
<u>UAN</u>								
100	5.7	166	12.9	18.5	17	147	8.2	3.7
<u>ProteFerm</u>								
17	5.8	133	10.5	11.0	14	113	9.1	7.1
33	5.9	229	14.7	20.4	19	119	11.4	10.1
67	5.6	282	21.7	19.1	14	138	8.7	22.1
<u>HLF</u>								
17	5.7	161	15.3	14.6	13	121	11.2	4.3
33	5.6	213	14.1	18.1	15	122	8.6	3.7
67	5.8	245	18.0	13.8	11	114	9.5	4.2
Maximum	6.4	440	33.9	36.4	27	171	18.7	45.4
Minimum	5.5	119	3.4	7.5	8	86	4.5	1.6
Average	5.7	206	15.3	16.0	14	123	9.8	6.7

^aPost-harvest soil samples.

Table 2. Corn responses to 150 lb of N/acre delivered with various N-percentages from by-products.

150 lb N % N from source	<u>Leaf</u> N	<u>Harvest grain</u> Moisture	<u>Harvest grain</u> Yield	<u>Post-harvest stalk composition</u> NH ₄ -N	<u>Post-harvest stalk composition</u> NO ₃ -N	<u>Post-harvest stalk composition</u> Inorg. P	<u>Post-harvest stalk composition</u> Cl	<u>Post-harvest stalk composition</u> SO ₄ -S
----- % ----- bu/ac ----- mg kg ⁻¹ -----								
<u>UAN</u>								
100	2.53	20.8	234	33	67	16	4,257	154
<u>ProF</u>								
17	2.52	20.9	221	24	71	14	6,981	124
33	2.67	20.9	223	30	64	16	9,185	164
67	2.40	20.9	216	12	72	13	9,017	166
<u>HLF</u>								
17	2.51	20.7	224	17	44	11	4,167	202
33	2.65	20.6	225	19	89	14	2,786	176
67	2.52	20.4	226	27	18	16	3,843	288
Maximum	2.84	21.3	250	82	311	56	10,756	485
Minimum	2.16	19.8	210	4	0	5	1,669	108
Average	2.51	20.8	224	24	74	14	4,802	193