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# Corn and Soil Test Response to By-Product Nitrogen Sources

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**Abstract**
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) assulfate ($SO_4$).

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# 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 ($SO_4$).

## 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 $SO^4$-S from ProF or HLF, respectively. Ammonium ($NH_4^+$) contents at this time were greater with the addition of N from either ProF or HLF. Generally, inclusion of either Cl or $SO_4$-S will retard $NH_4^+$ nitrification. Nitrification is the biologically facilitated conversion of $NH_4^+$ to nitrate ($NO_3^-$). P and K values for the site were low or just adequate which indicates a need for their application in the next crop cycle. $SO_4$-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 $SO_4$-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 $NH_4$ but $NO_3$ 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 $SO_4$-S increases with its application, $SO_4$-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 | pH | Electrical conductivity | $NH_4$-N | $NO_3$-N | Bray1-P | K | $SO_4$-S[a] | Cl |
|---|---|---|---|---|---|---|---|---|
| % N from source | | dS $cm^{-1}$ | ---------- mg $kg^{-1}$ ---------- | | | | | |
| UAN | | | | | | | | |
| 100 | 5.7 | 166 | 12.9 | 18.5 | 17 | 147 | 8.2 | 3.7 |
| ProteFerm | | | | | | | | |
| 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 |
| HLF | | | | | | | | |
| 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 |

[a]Post-harvest soil samples.

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

| | Leaf | Harvest grain | | Post-harvest stalk composition | | | | |
|---|---|---|---|---|---|---|---|---|
| 150 lb N | N | Moisture | Yield | $NH_4$-N | $NO_3$-N | Inorg. P | Cl | $SO_4$-S |
| % N from source | -------- % -------- | | bu/ac | ---------- mg $kg^{-1}$ ---------- | | | | |
| UAN | | | | | | | | |
| 100 | 2.53 | 20.8 | 234 | 33 | 67 | 16 | 4,257 | 154 |
| ProF | | | | | | | | |
| 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 |
| HLF | | | | | | | | |
| 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 |