Making Sense of Nitrogen Credits for Corn Production

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Introduction

Increasing nitrogen (N) fertilizer costs makes an accurate assessment of corn N needs more important than ever. Accurate determination of N fertilizer needs in corn production requires information about the amount of N necessary to optimize yield and estimates of how various factors influence the amounts of N available from non-fertilizer sources. Potentially important non-fertilizer N sources include legume forages and cover crops in rotations, manures, soybean in rotations, and soil N contributions. Crediting or accounting for N from these sources is essential for profitable corn production.

Determining Corn Nitrogen Needs

The key initial step in crediting N from non-fertilizer sources is to obtain a reliable estimate of the corn N requirement appropriate for the production situation. Usually this involves reference to N rate guidelines or recommendations for corn provided by University Extension or other sources. Recently, there has been a shift from the use of yield-based recommendations to those based on corn N response data and economic considerations. An interesting history of N recommendation approaches used in Indiana has been compiled by Dr. Jim Camberato (http://www.agry.purdue.edu/ext/soilfertility/historical-recommendations.html). Several Corn Belt states have adopted a similar approach to corn N recommendations based on corn N response data and corn and N fertilizer prices. This approach seeks to maximize economic return N fertilizer use. The rationale and data base for these guidelines, known as the maximum return to nitrogen (MRTN) approach, are described in the publication "Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn" (PM 2015-April 2006). (http://www.agronext.iastate.edu/soilfertility/nutrienttopics/nitrogen.html). A Web-based calculator for corn N rate guidelines using the MRTN approach is available at (http://extension.agron.iastate.edu/soilfertility/nrate.aspx). Currently, N rate recommendations for corn following soybean based on Indiana N response data can be obtained from this Web site.

Legume Forages and Cover Crops

Established forage legumes can contribute most or all of the N needed by a following corn crop, and legume cover crops can provide smaller, but significant amounts of N. Given the current N fertilizer prices, the value of N credits for a previous forage legume crop can exceed $100 per acre. Nitrogen credits for forage legumes are influenced by crop species, stand density, and amount of top growth remaining when rotation to corn occurs. (http://learningstore.uwex.edu/Nutrient-Application-Guidelines-for-Field-Vegetable-and-Fruit-Crops-in-Wisconsin-P185C43.aspx). Nitrogen in legume crops that may become available to a following corn crop is distributed throughout the top growth

and root systems of the plants. Therefore, N credits for these legumes are influenced by the amount of growth present and removal of plant material through harvest.

Nitrogen Credits for Manures

Depending on nutrient availability and application rate, manures can also provide the entire corn N requirement. As with legume N credits, nutrients provided by manures have increased in economic value due to higher fertilizer costs. Since manures contain substantial amounts of phosphorus and potassium in addition to N, the value of typical manure applications is now substantial, and this makes accurate crediting critical for profitable corn production. Accurate crediting of manure N requires information on the rate of manure applied and on the availability of N in manure. For most manure, the amount of N available to crops in the year of application is substantially less than the total amount of N in the manure. For example, only 50% to 65% of the N in typical liquid swine manure will be plant available in the year after application. Availability of N in manure is influenced by animal species, form of manure (solid or liquid), and method of application (surface, incorporated, or injected). University Extension services in most states provide estimates of N availability and N credits for various manures. Local information on N availability in manures or manure analysis provides the best basis for crediting this N against corn N needs.

Nitrogen Credits in Soybean-Corn Systems

Corn following soybean usually requires less N than corn following corn, and thus some adjustment in N rates is needed where soybean is included in the crop sequence. This soybean N effect differs from the N credits assigned for previous legume crops and manures in that soybean harvested for grain removes more N than the crop fixes from the atmosphere. Therefore, the soybean N effect is likely due to enhanced net N mineralization in soils rather than a direct N contribution from the soybean crop. The size of the soybean N contribution is usually 30 to 40 lb N/acre, and this amount is subtracted from the corn-corn N requirement. With the emergence of the MRTN approach to making N recommendations, the soybean N effect can best be accounted for using N rate recommendations based on N response trials conducted with corn following soybean (Concepts and Rationale for Regional Nitrogen Rate Guidelines for Corn, PM 2015-April 2006).
(http://www.agronext.iastate.edu/soilfertility/nutrienttopics/nitrogen.html).

Studies of factors influencing the soybean N effect show that soybean grain yield is not related to the apparent N contribution. Soybean residue management following grain harvest (residue removed or not removed) also did not influence the soybean N contribution. This observation lends support to the idea that the soybean N effect arises from increased net soil N mineralization in soybean-corn systems.

Residue Effects on Nitrogen Availability in No-till Corn

No-till corn following corn is more susceptible to slow early growth and N deficiency, especially in northern production areas. This suggests that no-till corn on corn could benefit from additional N relative to tilled production systems. Residue management research in no-till corn showed that corn residue removal or addition influenced soil temperature which, in turn, affected net soil N mineralization (Andraski and Bundy, 2008. Agron. J. 100:1274-1279). An artificial residue treatment (polypropylene) performed similarly to normal corn residue with respect to soil temperature effects and soil N mineralization. Lower soil temperature rather than N immobilization by residue was the main cause of lower net soil N mineralization in the high residue no-till system. Therefore, increasing N rates by about 30 lb N/acre may provide benefits in some years in no-till corn residue systems.

Soil Nitrogen Contributions

The most difficult N contribution to assess is the amount of available N supplied by the soil (N supplying capability, NSC). This can be a significant component of the corn N supply with more than 50% of the crop N need coming from this source (http://www.agronext.iastate.edu/soilfertility/nutrienttopics/nitrogen.html). Although many N availability tests have been evaluated for predicting soil N supplying capability, none have proven satisfactory. The emerging MRTN method of making corn N rate recommendations based on N response data and the economics of N and corn prices partially accounts for soil NSC since the average NSC is reflected in the corn N response data base used to develop the recommendations. However, the need remains to develop a site-specific technique to predict the amount of available N that the soil will furnish.

Diagnostic tests such as the presidedress soil nitrate test (PSNT) can be useful for predicting corn N needs or assessing non-fertilizer N contributions. The PSNT has been found useful for predicting corn N needs particularly where contributions from legume forages and/or manures are expected. The PSNT critical value (20-25 ppm nitrate-N) in the top foot of soil when corn plants are 6 to 12 inches tall is applicable across a wide geographic area, but the test is influenced by early season soil temperature in northern production areas. In Indiana, the interpretation of PSNT results on 1-foot soil samples indicates that no additional N is recommended and no yield response is expected when PSNT values exceed 25 ppm nitrate N, and the full rate of N is needed when PSNT values are in the 0-10 ppm nitrate-N range (Brouder and Mengel, 2003). (http://www.agry.purdue.edu/ext/pubs/AY-314-W.pdf).

Managing Nitrogen to Avoid Losses

Once the amount of fertilizer N needed to optimize yields has been determined, management techniques such as source, timing, and placement of the fertilizer N can influence the effectiveness of the applied N. For example, fall-applied N has an average effectiveness that is 10-15% less than the same amount of N applied in spring, and surface applications of urea-containing fertilizers are subject to losses through ammonia

volatilization that can range from 0-25%. Minimizing potential losses though effective use of management practices is key to optimizing economic returns from fertilizer N.

Summary

Increasing N fertilizer costs make accurate assessment of corn N needs more important than ever. The maximum return to N (MRTN) approach to corn N recommendations provides the best approach to identifying corn N needs and simultaneously considering current corn and N fertilizer prices. Legume crops in rotation with corn and N in manures can supply important amounts of N for corn production. Previously, the N contributions from manures and legumes were often discounted or viewed as "insurance" nutrient inputs; however, current economics suggests that N from these sources should be carefully considered. Where corn is grown in rotation with soybean, the reduced N need for corn should be accounted for either through crediting or by using N recommendations based on soybean-corn N response data. In no-till corn on corn systems, some additional N may be useful where soil temperature and soil N mineralization are reduced by the residue cover. Although soil N mineralization can supply a major portion of corn N needs, the size of this contribution is difficult to predict. Using corn N recommendations based on N response data will reflect the average soil N contribution. The presidedress soil nitrate test can also be useful for confirming N contributions from legumes and manures and for assessing soil N mineralization. Once the amount of fertilizer N needed has been determined, use of management practices to control losses of applied N through ammonia volatilization or from fall N applications is essential.