Understanding Nitrogen Availability

- Many factors can influence the availability of nitrogen in the spring: type of fertilizer and specific nutrient compound applied, soil type, use of stabilizers, and weather conditions.
- In order to help maximize crop yield potential this season, it is important to determine the amount of nitrogen available for plant uptake this spring and identify further management steps needed throughout the season.
- The availability of N in the soil can be influenced by the possible N loss mechanisms of leaching, denitrification, and volatilization.

Determining Nitrogen Availability

Because so many factors affect nitrogen (N) loss and the amount of N in soils, it can be difficult to accurately estimate the amount of N available to plants. Soil testing to determine the level of nitrate and ammonium forms of N can help estimate the amount of N loss due to rainfall or flooding. Soil cores should be collected to a depth of at least one foot. In sandy soils prone to leaching, sampling at a greater depth may help to identify plant-available N deeper in the soil profile. If fertilizer was broadcast in the fall or early spring, collect 20 to 30 cores per sample. If previously applied fertilizer was banded, samples should contain 15 to 20 soil cores. Samples should be collected perpendicular to the direction that fertilizer was applied. Each sample should represent no more than 10 acres. Samples should be dried or refrigerated as soon as possible to stop soil microbial activity from changing N levels. Results indicating substantial levels of soil ammonium are more likely if anhydrous ammonia was recently applied, nitrogen stabilizers were used, or soil pH is 5.5 or less. In such cases, low levels of soil nitrate may mean that little conversion of ammonium to nitrate occurred rather than loss of nitrate from the soil due to leaching or denitrification.

The preplant soil nitrate test (PPNT) and the pre-sidedress soil nitrate test (PSNT) can be used to determine nitrate concentrations in soils. This makes it possible to predict the amount of N that will be available to plants during the growing season through mineralization. Most N is released from the soil in the spring when temperatures increase. The rate of N release from soils is influenced by soil temperature, moisture, and aeration. Sampling for the PSNT should be done when corn is 6 to 12 inches tall or in late May to early June. Soil cores should be taken at a depth of one foot with one sample containing 15 to 20 cores. Samples should come from field areas that are similar and no more than 10 to 20 acres in size. Fields that are likely to have high nitrate concentrations (manured, previous year in alfalfa, fine-textured, fall-tilled, south-facing slopes) should be sampled. Although some differences exist in University recommendations for interpreting PSNT results, a general rule of thumb is that if soil test results are over 23 to 25 ppm, additional nitrogen is probably not needed.

Nitrogen Sources

Nitrogen (N) can be supplied for plant growth in several ways. Atmospheric N is a major component of the N cycle. Legumes such as soybean and alfalfa can use this type of N via N fixation. Decomposing plant material from these legume crops will release N into the soil. Small amounts of atmospheric N are also added to the soil through precipitation.

Soil organic matter is composed mainly of humus and is an important source of N for plant growth. Organic N is converted to nitrate and ammonium and made available to crops through a process called mineralization. Decomposition of humus occurs at a slow rate and can release about 20 lb N per acre per year for each percent of organic matter in the soil.

Additional sources of N include organic wastes such as manure, crop residues from non-leguminous plants, and commercial N fertilizers.

Nitrogen Fertilizers and Risk of Loss

Nitrogen fertilizers contain N in one or more forms: ammonia (NH₃), ammonium (NH₄⁺), nitrate (NO₃⁻), or urea (CO(NH₂)₂) (Table 1). Ammonia is a gas, which becomes liquid under pressure. When anhydrous ammonia is applied, the ammonia is converted to ammonium in the soil. Ammonium binds to clay and organic matter in the soil, which prevents it from leaching. Soil microorganisms convert ammonium to nitrate — the main form of N taken up by plants. Conditions favorable to this process of nitrification are a soil pH of 7, soil moisture at 50% of holding capacity, and a soil temperature of 80°F. Nitrate can be subject to leaching. Excessive rainfall can leach nitrate out of the root zone making it unavailable for plant use.

When soils are waterlogged, soil organisms take oxygen from nitrates. This process, called denitrification, converts NO₃⁻ to N₂O and N₂, which are gaseous forms of N that ultimately can escape into air. This type of N loss occurs most often in fine-textured soils subjected to prolonged anaerobic conditions.

Urea is converted to ammonia 2 to 4 days after application when soil moisture and temperature are favorable. Lower temperatures will slow the process. Urea is first converted to ammonia, then to ammonium, and finally to nitrate. Volatilization can occur when urea is applied to the soil surface and is more likely to occur with high soil temperatures, low soil moisture, and soil pH greater than 7. No matter what form of N fertilizer is used, most of the N will be converted to nitrate in the soil.
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| Table 1. Common Nitrogen Fertilizer Options |
|-------------------------------|----|---------------------------------|-----------------|-----------------|
| **Fertilizer Type** | **% Nitrogen** | **Risk of N loss and other considerations** | **Suggested use** | **Suggested use** |
| Ammonium nitrate | 33-34 | Half ammonium N and half nitrate N; not recommended for soils subject to leaching or denitrification; can be surface applied where volatilization of urea is a concern | Side-dressing corn | Spring preplant |
| Ammonium sulfate | 21 | Little risk of loss to surface volatilization on most soils; requires 2-3 times more water to neutralize acidity compared to other N fertilizers | Side-dressing corn | Fall application |
| Anhydrous ammonia | 82 | Converts to nitrate N slowly, so less risk of loss due to leaching or denitrification; must be injected into soil, therefore little risk to surface volatilization; can be hazardous to handle | Side-dressing corn | Fall application |
| Urea | 45-46 | Converts to nitrate N relatively quickly; denitrification on wet/compacted soils can be serious; leaching can be a problem; surface volatilization can occur when temperatures are above 50° F; therefore needs to be incorporated | Side-dressing corn | Spring preplant |
| UAN | 28-32 | Usually consists of urea + ammonium nitrate; each component has the same loss mechanisms as mentioned above | Side-dressing corn | Spring preplant |

*Source: Mengel, D. Types and uses of nitrogen fertilizers for crop production. AY-204. Purdue University Cooperative Extension.

Nitrogen Stabilizers

Nitrogen additives can be used to delay N transformations and prolong N availability. If N stabilizers are used with N fertilizer applications, the amount of N loss may be reduced, even if weather conditions are not ideal. There are two categories of N stabilizers generally used: nitrification inhibitors and urease inhibitors. Nitrification inhibitors N-Serve® and Instinct® (nitrapyrin) inhibit soil bacteria responsible for denitrification, slowing the conversion of ammonium to nitrate. N-Serve is primarily used with anhydrous ammonia and labeled for immediate incorporation or injection. Instinct is an encapsulated formulation of nitrapyrin that can be applied to fertilizer left on the surface for up to 10 days. Urease inhibitor Agrotain® (NBPT) is intended for broadcast, surface-applied urea and UAN (urea ammonium nitrate) fertilizers. Agrotain inhibits soil urease conversion of urea to ammonia to allow more time for rainfall to incorporate urea-based fertilizers. Agrotain® Plus is an additive for UAN solutions that combines the urease inhibitor to reduce volatilization loss with dicyandiamide to hinder nitrification.

Summary

Sampling and testing soil may be necessary this spring to help determine whether additional N will be needed to help maximize crop yield potential. Availability is influenced by many factors, but a study from the University of Wisconsin found that “regardless of the rate or source, the fate of fall- and spring-applied N is mostly impacted by weather conditions in early spring.”

Sources


Web sources verified 2/10/2015.

For additional agronomic information, please contact your local seed representative.

Individual results may vary, and performance may vary from location to location and from year to year. This result may not be an indicator of results you may obtain as local growing, soil and weather conditions may vary.

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