Enhanced-Efficiency Nitrogen Sources

Introduction

In times of high production costs and fluctuating fertilizer and milk prices, there is an increasing interest in the use of nitrogen (N) sources that reduce the risk for N loss. Various technologies have been developed to minimize the potential for N loss to the environment, including technologies that delay nitrification (nitrification inhibitors), delay conversion of urea to ammonium (urease inhibitors), and/or use of sulfur or polymer coatings to release N over a longer time period (slow or controlled release). In this factsheet we explain how the different technologies impact N cycling and N loss potential to the environment and the conditions under which use of these materials would be most effective.

Nitrification Inhibitors

Nitrification inhibitors are substances that inhibit conversion (biological oxidation) of ammonium to nitrate. So, nitrification inhibitors work by keeping N in ammonium form, which is done by inhibiting *Nitrosomonas* bacteria, delaying conversion for four to ten weeks depending on soil temperature and pH.

These inhibitors can reduce N loss from leaching and denitrification but are only effective on fertilizers that either contain or are converted to ammonium, including anhydrous ammonia, urea, and ammonium sulfate.

In our humid climate, nitrification inhibitors have the highest likelihood for a yield response when applied at planting in poorly drained soils (where denitrification losses might occur) or in sandy soils (where the leaching potential is high) (see Fact Sheet #11). They are less likely to prevent loss when N is sidedressed.

Examples of commercially available nitrification inhibitors are N-Serve (Dow AgroSciences) with nitrapyrin as the active ingredient, and Guardian (Conklin), with dicyandiamide (DCD) as the active ingredient.

Nitrification inhibitors can be added to solid fertilizers. The mixture should be applied quickly after mixing to avoid volatilization of the inhibitor.

Urease Inhibitors

Urease inhibitors are substances that inhibit conversion (hydrolysis) of urea to ammonia and carbon dioxide, reducing ammonia volatilization losses. Urease inhibitors can be effective for up to ten to fourteen days. Urease inhibitors especially target N sources that have a high volatilization potential (e.g. urea) in situations in which tillage incorporation is not possible (e.g., no-till, pasture, and grass hay production). Adding a urease inhibitor allows more time for rain to incorporate the N fertilizer.

An example of a urease inhibitor is Agrotain (Agrotain International LLC) with NBPT (N-butyl thiophosphoric triamide) as the active ingredient.

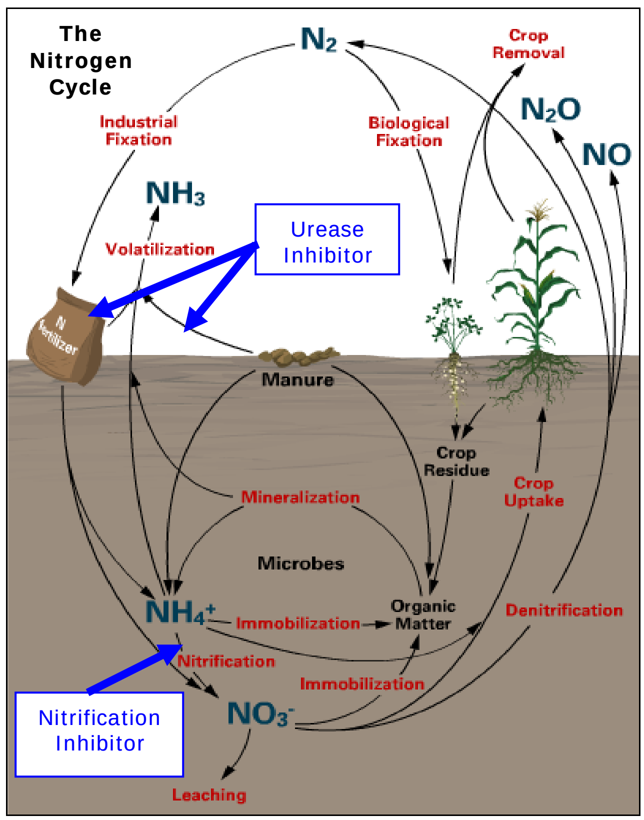

Figure 1: Nitrification inhibitors slow the conversion of ammonium to nitrate and reduce losses through leaching. Urease inhibitors slow the conversion of urea to ammonia and help reduce volatilization.

Slow- and Controlled-Release Fertilizers

Slow-release fertilizers minimize the potential of nutrient losses to the environment by slowly converting to ammonium and/or nitrate over time. These N sources can reduce N losses, especially in sandy soils more prone to N loss, and help extend N availability over a full growing season. Slow-release fertilizers release more slowly than soluble N sources. Their release is limited mostly by temperature and/or moisture. An example of a slow-release fertilizer is Nitroform (Nu-Gro Technologies). In this product, approximately two-thirds of N is insoluble in water, needing microbial activity to be released.

Controlled-release fertilizers are usually common fertilizers such as urea, coated with a polymer or with sulfur. The coating delays the availability of the nutrients for plant uptake after application and controls nutrient release over time. These enhanced-efficiency fertilizers allow for better timing of N release, consistent with crop growth and N demands.

For sulfur-coated fertilizers, N is released upon the physical breakdown of the sulfur coating followed by soil microorganisms completing the degradation and N release process. For polymer-coated fertilizer, N is released when water enters the granule and dissolves the urea or other N forms inside it into a liquid N solution, and the solution diffuses through the coating into the soil solution. The N diffusion rate is influenced by soil temperature; more N is released during warmer, active growing periods and less in cooler, inactive periods.

There are advantages and potential disadvantages for the use of controlled-release fertilizers. They can reduce leaching, denitrification and/or volatilization losses, and can result in more uniform growth because of reduced risk of seedling burn or salt damage. However, these products do tend to be more expensive per unit of N and are not desirable when a quick release is needed, for example, when sidedressing corn at the 6-leaf stage. In addition, some products, if applied on bare soil, should be incorporated to prevent runoff with heavy rains.

Some examples of controlled-release urea are ESN (Agrium), Osmocote (Scotts), and Isobutylidene diurea (IBDU, made by Nu-Gro).

Summary

The ultimate goal of enhanced-efficiency N sources is to better match N release with the timing of crop N demand. In many situations they may eliminate the need for an additional trip over the field (e.g., a sidedress application of N for corn). Enhanced-efficiency N sources are usually more expensive per unit N than conventional N sources, so it is important to understand under what weather and soil conditions enhanced-efficiency N sources could be an economically sound investment. Nitrification inhibitors, urease inhibitors, slow-release and controlled-release fertilizers can all help improve N fertilizer efficiency, but the economic benefits of these products are weather- and management-specific, and therefore not always consistent. Furthermore, the use of enhanced-efficiency N sources only makes sense if soil N supply plus N credits from manure and/or rotation crops, is insufficient to meet N needs of the current crop.

When adding the right source, at the right rate, at the right time, and with the right placement, both conventional and enhanced-efficiency N fertilizers can help produce high quality and high quantity crops with reduced impact on the environment.

Additional Resources

- Cornell University Agronomy Fact Sheet #2 (Nitrogen Basics – The Nitrogen Cycle), #4 (Nitrogen Credits from Manure), #11 (Nitrogen Leaching Index), #21 (Nitrogen Needs for First Year Corn), #30 (Soybean Nitrogen Credits), #35 (Nitrogen Guidelines for Corn), and #44 (Nitrogen Fertilizers for Field Crops). http://msp.css.cornell.edu/publications/factsheets.asp.

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For more information

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2009