Nitrogen Fertilizers for Field Crops

Introduction

With the increased cost of nitrogen (N) fertilizer and concerns about the adverse environmental impacts of N losses, there is great interest in fine-tuning N fertilizer management. The goal is to match application source, rate, timing and method to supplement on-farm sources of N (e.g., manure, soil organic N, sod, legume cover crops) to meet crop needs and achieve optimum levels of N use efficiency. Optimum N fertilizer management requires an understanding of the different N fertilizers. In this fact sheet we will discuss the basic properties of major N fertilizer sources.

Urea

Urea is a highly soluble, dry material. Its N becomes plant-available when converted to ammonium (NH_4^+) and then nitrate (NO_3^-). Urea can be used as a starter, broadcast or topdress application and can be used in fertilizer mixes (dry or liquid). Advantages of urea are its high N content (45 to 46%), relatively low cost per lb of N, and rapid conversion to plant-available N. If urea is surface applied and not incorporated (either by rain or tillage), N losses to the air (as ammonia) can approach 40% of the applied N. In addition, a rapid pH increase after application caused by hydrolysis of urea can result in ammonia release that can damage seedlings if the urea is applied too close to the seed. If urea is used as a band-applied starter, the planter should be carefully checked to ensure placement is not closer than 2 inches beside and below the seed, and be calibrated to apply no more than 60 lbs urea per acre (30 lbs of actual N from urea). Conversion of ammonium to nitrate results in the formation of hydrogen ions (H^+), so, like most N fertilizers, repeated urea applications will cause a reduction in soil pH over time.

Urea Ammonium Nitrate

Urea ammonium nitrate (UAN) is a soluble, readily available N source with 28-32% N prepared by mixing of ammonium nitrate and urea. It is primarily used as a non-pressurized liquid fertilizer and is for many the preferred source of N for sidedressing of row crops. UAN can be broadcast or placed in the starter band. If broadcast, UAN should be incorporated into the soil as the urea portion is subject to volatilization. However, because of its lower % of N in urea and ammonium form, volatilization losses per pound of N from UAN will be lower than for urea. Banding with drop nozzles has been found to minimize volatilization losses. The benefits of this product are its uniformity, ease of storage, handling and application. Like urea, UAN will lower the pH because of conversion of ammonium to nitrate and subsequent release of H^+.

Figure 1: Urea ammonium nitrate in liquid form is a commonly used fertilizer to sidedress corn.

Ammonium Sulfate

Ammonium sulfate is a soluble, readily available source of N and sulfur (S). Dry forms contain 21% N and 24% S, while liquid forms have an analysis of 8-0-0-9. Ammonium sulfate can either be broadcast or applied in the starter band. In high P and K fertility situations, many NY producers use ammonium sulfate alone in the starter band. Ammonium sulfate is well-suited as a topdress application as it has a lower N volatilization risk than surface-applied urea. Also, where S is needed,

ammonium sulfate is a good source of S.

The drawbacks to using ammonium sulfate include a relatively high salt index and greater acidification potential per unit N applied than other ammonium-containing N sources, higher cost per lb of N, and relative low N content, requiring more frequent refilling of hoppers.

Anhydrous Ammonia

Anhydrous ammonia has the highest percentage of N of all fertilizers (82% N) and tends to be the cheapest N source (cost per unit N). It is a high-pressure liquid that can be deep-banded before, at or after seeding provided that there is no direct seed contact. Anhydrous ammonia must be injected 6 to 8 inches deep into moist and friable soil to limit ammonia loss (liquid ammonia converts to gas when no longer under pressure). It must be stored under high pressure, which requires specially designed, well-maintained equipment and facilities should be well-protected for safety reasons. During application, personal protective equipment (gloves and goggles) should be used.

Ammonium Nitrate

Ammonium nitrate is an odorless salt with 33 to 34% N. It can be surface-applied or incorporated into the soil. It contains both ammonium and nitrate resulting in reduced volatilization risk as compared to urea, and the nitrate provides a directly available N source. Since it contains ammonium, this fertilizer also lowers the pH of the soil.

Potassium Nitrate

Potassium nitrate, also known as saltpeter or nitric acid, is considered a specialty fertilizer. It is a colorless transparent crystal or white powder with 14% N and 46% potassium (K). Potassium nitrate does not lower the soil pH.

Mono-Ammonium Phosphate

Mono-ammonium phosphate (MAP) contains readily available sources of N (11%), P (52%) and S (1.5%). MAP is a dry granular material that is applied alone or often blended with other materials such as potash. It can be broadcast, band-applied or placed in the seed furrow. MAP can lower the soil pH but is an excellent starter fertilizer.

Di-Ammonium Phosphate

Di-ammonium phosphate (DAP) is dry fertilizer that contains readily available sources of N (18%) and P (46%). Formation of free ammonia produced after mixing of DAP with soil can cause seedling injury as described for urea. To prevent such injury using DAP, it is recommended to limit band-applications to (1) 65 lbs per acre of DAP, or (2) 30 pounds of urea N plus N from DAP.

Chilean Nitrate

Chilean nitrate can be used in conventional and organic cropping systems (permitted for use by USDA/NOP in 2003). It contains 16% of a readily plant-available form of nitrate-N and sodium. It is available in a dry, flowable prill form.

Enhanced-Efficiency Nitrogen Sources

Enhanced efficiency N sources are designed to reduce losses of N due to leaching, denitrification and/or volatilization. For more information on these enhanced-efficiency fertilizers see Agronomy Fact Sheet #45.

Concluding Remarks

Applying the right source of N fertilizer at the right rate, time, and place is critical to proper N management. For the best results, apply N only when needed, calibrate application equipment to ensure proper placement, and adjust source, rate and timing to meet N needs and avoid seed or seedling injury.

Additional Resources

- Nutrient Management Spear Program Agronomy Fact Sheet Series. http://nmsp.css.cornell.edu.

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
http://nmsp.css.cornell.edu

John Weiss, Tom Bruulsema (IPNI), Mike Hunter, Karl Czymmek, Joe Lawrence, Quirine Ketterings

2009