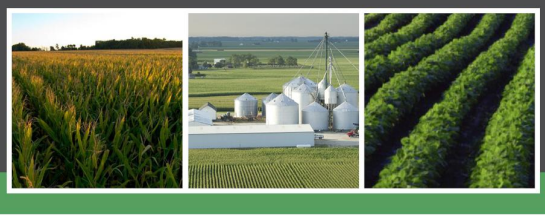

Agronomic Spotlight

Nitrogen Optimization in Corn

- Determining which nitrogen (N) plan is best for each situation includes understanding how timing, rate, source, and method of N fertilizer application can affect the corn crop.
- The efficient use of N is affected by not only the corn crop itself, but also by the possible N loss mechanisms of leaching, denitrification, and volatilization.
- The advantages and disadvantages for each source of N fertilizer under each situation should be compared before deciding which product, rate, and application method to use.

Optimizing N use in corn involves a balance of providing the appropriate amount of nutrient to the crop at the right time while preserving profit margin and reducing N loss to the atmosphere, surface water, and groundwater. Timing, source, rate, and method of application, as well as N loss mechanisms, all play a role in this balancing act.

N Loss Mechanisms

The efficient use of N is affected by not only the corn crop itself, but also by the opportunities for N loss in the N cycle. The primary mechanisms for N loss in corn fields include denitrification, leaching, and volatilization.

Denitrification is the process by which soil bacteria that thrive in saturated (anaerobic) soils convert nitrate-N into gaseous forms of N. Volatilization of the N gas can result in as much as 5% nitrate-N loss per day.[4] This occurs in heavy, poorly-drained soils and those that are compacted enough to restrict drainage.

Leaching refers to the process by which nitrate-N moves downward in the soil profile out of the root zone with excessive rainwater. UAN and nitrate-containing fertilizers are highly susceptible to leaching, especially on coarse-textured soils.

Volatilization of urea-based fertilizers can occur if they are surface-applied and not incorporated. Urease enzymes in soil and plant residue convert urea to free ammonia gas. On warm, sunny days, up to 15 to 20% urea-based N can volatilize within a week of application.[4]

Some products that can be used to inhibit or delay N losses include: nitrification inhibitor (N-Serve®), urease inhibitor (Agrotain®), and polymer coated urea (ESN®). Sidedressing N is an application method that can also be used for reducing the risk of N loss.

Timing N Application

Timing of application can be influenced by factors such as weather and workload. It is desirable to apply N as close to the period of rapid plant uptake as possible so that there is reduced risk of N loss prior to plant use. Sidedress applications are preferred over preplant, and preplant applications are preferred over fall applications in synchronizing N application to rapid crop N uptake.[1]

Fall application has a greater risk of N loss, but is still practiced to take some workload off the busy spring schedule. If applying N in the fall is preferred, anhydrous ammonia is recommended because it has the lowest loss risk of any N fertilizer.[1,2] Anhydrous ammonia should be applied when soil temperature is less than 50° F and used in conjunction with a nitrification inhibitor to slow the conversion of ammonium to nitrate, further reducing loss risk.[2]

Spring pre-plant, sidedress, or split pre-plant/sidedress applications are preferable due to less potential N loss and improved timing in relation to plant uptake. However, spring can also be a time of great potential N loss due to wet soils. If N is to be applied more than 2 weeks prior to planting, anhydrous ammonia is recommended to reduce the risk of loss.[1] Early N applications in river bottoms should be avoided due to N loss potential being highest with sandy or heavy textured soils.

When considering in-season N applications, the preferred method is injection of ammonia or UAN, followed by UAN dribbled between rows or broadcast urea.[2] Broadcast UAN is not a safe option, however, due to potential plant burn.

Sources and Application Methods

Two forms of N are used by plants: ammonium and nitrate. Other forms of N have to be converted to one of these forms in order for plants to use them. This may occur through natural or artificial means. There are several sources of N fertilizer available, each offering some degree of advantage in different situations.

Figure 1. Anhydrous ammonia application.

Anhydrous ammonia, NH3, is 82% N by weight. It is the most widely used N source because it is the most N dense form of N fertilizer. Anhydrous ammonia is a gas at normal temperatures that when pressurized is held in the liquid state. This liquid must be injected into soil to prevent loss to the atmosphere as a gas.

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Anhydrous can be applied in the fall, pre-plant, or sidedressed. It is converted to ammonium and available for plant uptake within 8 to 10 days after application. It is the only form of N that should be considered if fertilization is a must in the fall, and has the lowest risk for loss from a spring application. Anhydrous should not be applied when soils are wet, as the slots may not close properly causing ammonia gas to escape.[1]

The drawbacks to anhydrous use include the necessity to use pressurized containers and specialized equipment as well as additional safety precautions for handlers. Also, free ammonia can be dangerous for seedlings, so placement in relation to the corn seed is important.[2]

All other forms of N fertilizer are derived from anhydrous ammonia. They are less N dense and have a higher price per pound of N (due to the additional processing) but are generally easier to store and apply, and are safer to handle.[3]

Urea is a dry pellet fertilizer that is 46% N by weight. It has a relatively high N content, good storage and handling, and N is readily available to plants. However, it should not be broadcast and left on top of the ground. Urea should be incorporated with tillage, irrigation, or by precipitation within 3 to 4 days or treated with urease inhibitor to prevent N loss.[1] When applied as a band, urea can cause root and seedling damage if placed within close proximity to the seed.[2]

UAN (Urea-ammonium nitrate) is an aqueous solution containing 28% or 32% N by weight. It is composed of equal parts urea and ammonium nitrate. It is versatile and generally has widespread availability. UAN should not be broadcast on high residue surfaces, but instead applied via knife or coulter injection, or can be dribbled in a surface band to reduce residue tie-up.[1] Treatments such as urease inhibitors to reduce volatilization loss, if surface applied, are the same as with urea.

Ammonium nitrate is a dry N fertilizer that is 34% N by weight. It is composed of equal parts ammonium and nitrate. Both the ammonium and nitrate fractions are available for plant uptake. No special management is necessary and surface broadcast application is generally effective, but should not be done too far in advance of planting to reduce the risk of N loss by denitrification or leaching.

Application Rate

The rate of N applied is an important variable from both an economic and environmental standpoint. Before determining the rate of N fertilizer to apply to a crop, farmers must first estimate the amount of N available from soil and the total N need of the crop. This can be a difficult decision because of factors such as temperature and precipitation that affect the release of N (mineralization) from the soil and the crop's needs. Therefore, N application may vary from year to year and from field to field on the same farm.

Nitrogen application rates based on yield goals has been a common method to determine the amount of N application.[1] University recommendations advise to fertilize for normal yields, even in good years, because under those ideal conditions, the microbial activity leads to soils releasing more N to the crop.[1] Consider allotting more N for the areas with a greater potential response to N use by taking into consideration the spatial variability of N availability in a field.

Be sure to take into account all sources of N when considering application rates. Look at previous legume crops and manure application where applicable to calculate the amount of N supplied from those and credit it accordingly.

Summary

Nitrogen optimization in corn is a complex process involving many variables. The first step to determining which N plan is best for each situation includes understanding how timing, rate, source, and method of N fertilizer application can affect your farm. It is also important to understand how to prevent N loss to the environment. Finally, N managers must determine the amount of N that maximizes crop yield and profit margin while minimizing environmental losses.

Sources

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