BETWEEN THE ROWS

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Some growers who may have been counting on carryover nitrogen (N) from last year's drought stricken crop may need to reevaluate their nitrogen management plan. Large amounts of rain in the past two weeks raise questions about possible N loss and the need for supplemental N applications. Understanding the factors which influence nitrogen loss will help growers determine their specific situation and help them make more informed decisions.

Understanding Nitrogen Forms

One of the factors that influences nitrogen loss is the form present in the soil. Nitrogen exists in many forms and transforms from one form to another in a process known as the nitrogen cycle. Nitrogen is primarily introduced to the soil either through applied fertilizer, or the breaking down of crop residue and soil organic matter.

Nitrogen fertilizers can be divided into two categories: Ammonium fertilizers (anhydrous ammonia and ammonium sulfate) and urea-containing fertilizers (Urea, 28%, 32%, and manure). Ammonium fertilizers are applied in the ammonium (NH4+) form. Urea-containing fertilizers are often a combination of ammonium and nitrate (NO3-). If the nitrogen stays in the ammonium form, loss would not occur because it attaches to the soil and is immobile. However, ammonium will naturally be converted to nitrate through a process called nitrification. Nitrogen in the nitrate form can then be moved out of the soil profile or lost by leaching or denitrification.

The Nitrogen Cycle

The conversion of ammonium to nitrate (nitrification) and the conversion of nitrate to N gases (denitrification or volatilization) are processes that depend heavily on the given environment. Therefore, potential for N loss is dependent on factors that influence each of these processes.

Nitrification is greatly influenced by soil temperature. The process is faster with warm soils, while slow to nonexistent in cold soils. This is the reason it's recommended to wait until soils cool to 50°F in the fall before applying any ammonium fertilizers. If soil temperatures stay cool, the nitrogen will stay in ammonium form and be immobile. If soil temperatures warm above 50°F, nitrification will begin to take place and that ammonium will start to be converted by microbes to the more mobile nitrate form. When urea or urea-containing fertilizers are applied in the spring, they are usually converted to nitrate more rapidly than ammonium applied in either the fall or spring. Conversion to nitrate does not equal loss, but rather that it is more susceptible to loss.

Leaching can occur once the nitrogen has been converted to nitrate. Nitrate is water soluble and will not attach to the soil, so as water passes through the soil excess nitrate can move below the root zone in certain conditions. In general, leaching losses are more likely in sandy soils with low water holding capacity where water moves through the profile quickly. Another factor that influences the amount of leaching is subsoil moisture recharge. If subsoil moisture levels are not recharged, water is more likely to be held in the soil, therefore reducing the chances of leaching.

Denitrification only occurs when soils are saturated and in an anaerobic environment. This process is heavily influenced by temperature as well. (Figure 1)This table shows the amount of denitrification that can be expected at the given soil temperatures when soils are saturated for an extended period of time.

Figure 1.

Estimated denitrification N losses as influenced by soil temperature and days saturated.

SOIL TEMP (°F)	DAYS SATURATED	LOSS (% of applied)
55-60	5	10
	10	25
75-80	3	60
	5	75
	7	85
	9	95

If soils are still cool when the extended saturation occurs, the rate of denitrification is greatly reduced. Denitrification, in general, is more likely on fine textured, poorly drained soils where saturation is maintained for several days. Given that we have not seen soil temperatures rise to these levels on our saturated soils this spring, the risk of denitrification is reduced.

Volatilization occurs when nitrogen is in the organic form of urea, most commonly from animal manure or urea fertilizers. When this happens the nitrogen is changed to ammonia gas (NH3) and lost into the atmosphere. It is most likely to take place when soils are warm and moist and the source of urea is near the surface. Applying urea fertilizers when soil and air temperatures are cool and incorporating the fertilizer into the soil will reduce volatilization.

Preventing Nitrogen Loss

There are steps that can be taken throughout the year to minimize nitrogen loss. When to implement these will depend upon what form of nitrogen you are applying, when it is applied, and the environment in which it is applied.

There are products available, known as nitrification inhibitors, which slow the nitrification process allowing nitrogen to stay in the immobile ammonium form later into the year. These products can be used in fall and spring applications to delay nitrification until later in the spring when the crop needs it, reducing the amount of nitrate that could possibly leach through the soil.

When applying ammonium in the fall, make sure to wait until soil temperatures fall below 50°F so that nitrification does not occur. Using a nitrification inhibitor will also help delay the nitrification process, preventing nitrogen loss.

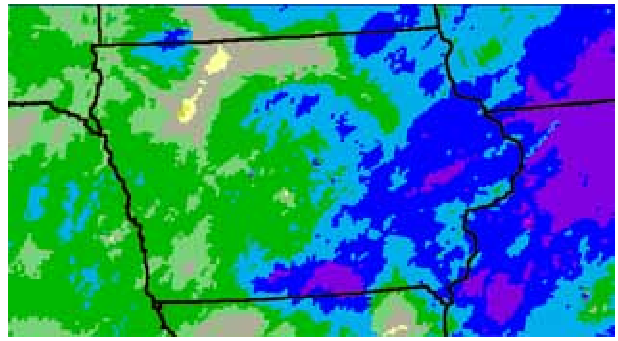
In the spring, when applying urea-containing fertilizers you can reduce volatilization by incorporating it into the soil. Urea will convert to nitrate much faster than ammonium fertilizer. Therefore, using nitrification inhibitors and avoiding application of the fertilizer too long before your projected planting date will reduce the amount of nitrogen lost.

Determining the need for supplemental N

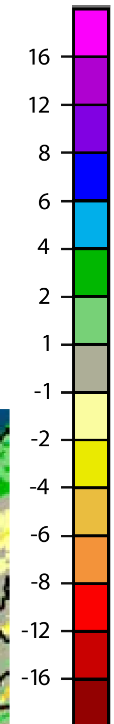
Nitrogen is one of the leading yield-limiting factors of a corn crop. Making sure that you have enough N present to reach your yield goal is important. Determining the amount of nitrogen you need to apply each year depends on a few variables. You first must set a yield goal to determine how much N will be required to meet that goal. Next you must determine how much N is available or will become available in the soil from the previous year's crop and crop residue. There are differing methods and formulas for determining the total amount of N to apply, but all are based off the same principles.

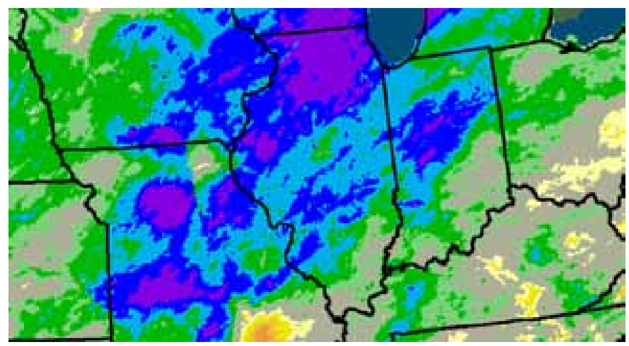
We generally do not see a lot of carryover N in the Midwest because it is already converted to nitrate and will leach out during heavy winter and spring precipitation events. This spring is no different. Much of the Corn Belt did not remove as much nitrogen with the crop because of reduced yields, therefore more nitrogen was thought to be left in the soil last fall. A dry winter and spring would allow some of the nitrate to carry over and be available for this year's crop. However, as you can see from Figure 2, most of the Midwest has had above average rainfall. And that means most nitrate has likely been lost by leaching or denitrification.

Because soil temperatures have not risen above 50° F for any extended period of time, fertilizers applied in the fall and spring are most likely still safe from leaching.



Rainfall departure from normal in inches, January 26-April 26





Rainfall departure from normal in inches, January 26-April 26

One way to determine the amount of N present in your fields is to use a soil analysis for NO3 and NH4. If you discover, or suspect, that there is not as much carryover nitrogen available , it would be wise to consider a supplemental application of N at some time during the growing season. This will help replace N lost during this period of above average rainfall.

Summary

Nitrogen is one of the most yield-limiting inputs, and we can control the amount available to our crop. But it's also one of our most costly inputs, so the decision to apply supplemental nitrogen has to be well thought out. Not having enough nitrogen available to maximize yield can be a painful mistake. The common notion that carryover N may be available from last year's drought stricken crop may have to be reconsidered given the wet spring we have experienced thus far.

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