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Nitrogen Loss – How Does it Happen?

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Abstract
Much of Iowa is experiencing excessively wet conditions this spring. With the continued large rainfalls and flooding conditions, nitrogen (N) loss is an issue. While the wet period early this spring had an influence on N in the soil, excessively wet conditions now are especially critical for N losses due to warm soils and considerable conversion of applied fertilizer and manure N to nitrate.

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Nitrogen Loss – How Does it Happen?

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This month will be an important period to assess crop conditions, productivity potential and needed N applications. Remember, if the corn crop is severely damaged by excess water, application of N will not overcome that damage and lost yield potential. In some cases, application of additional N will not be warranted. This is the first of a series of three articles discussing N losses this spring.

Nitrogen Processing in Soil

If applied N or mineralized organic matter N (conversion from organic to ammonium) would stay in the ammonium (NH_4^+) form, then losses would not occur because ammonium attaches to soil and does not leach (move through the soil with water) or denitrify (microbial conversion to N gases when soils become saturated). Unfortunately, that isn't the way it works. Ammonium is converted to nitrate (NO_3^-) via nitrification.

Nitrate is the form that can be moved out of the soil profile by leaching or lost by denitrification. The conversion of ammonium to nitrate and the conversion of nitrate to N gases are both microbial processes. Hence, potential N loss is dependent upon factors that influence each – for nitrification, soil temperature is very important (faster with warm soils, slower with cold soils), for denitrification, soil temperature, soil moisture (only occurs when soils are saturated – anaerobic conditions) and readily available organic matter for an energy source. If fertilizer N is applied in the nitrate form, then that N is immediately subject to these loss pathways. Mineralization does occur when soils are saturated, so ammonium can accumulate in flooded soil and add to crop available N.

Potential for N losses

Greater losses occur when soils enter the spring season with recharged subsoil moisture, when more N is in the nitrate form and when soils are warm. Deciding if losses are substantial enough to warrant supplemental N application, the following factors should be considered:

1. amount of nitrate present, which is affected by time of N application, form of N applied, rate applied, and use of a nitrification inhibitor;
2. when and the length of time soils are saturated;
3. subsoil recharge, leaching rate, and drainage – water amount moved through the soil; and
4. loss of crop yield potential from water damage.

Leaching and denitrification are not uniform across the landscape. Thus, the potential for N loss is variable and difficult to predict. For example, with high intensity rains, runoff occurs and not all of the water soaks into the soil. Instead, water in excess of infiltration moves to the lower landscape where it may form ponds or spill over stream banks into floodplains.

An important consideration is the conversion to nitrate. In Iowa, a substantial amount of anhydrous ammonia and ammonium containing manure is fall applied. The computer simulation model "*Fate of Anhydrous Ammonia in Iowa Soils*," developed at ISU by R. J. Killorn and S. E. Taylor, indicates that in a cooler-than-normal scenario, and with ammonia applied November 1, 30 percent or more of the ammonium would be converted

to nitrate by May 1 (with use of the nitrification inhibitor N-Serve, estimated ammonium remaining on May 1 would be about 75 percent for a November 1 application).

With cool spring temperatures and an April 1 application, by May 1 approximately 70 percent or less would still be ammonium and by June 1, 45 percent or less. For a May 1 application and cool temperatures, by June 1, 50 percent or less would remain as ammonium.

The winter and early spring were cold this year, which would result in slower than normal nitrate formation. However, the wet soils are continuing well into June and soils have warmed, and unless ammonium fertilizer or manure was applied recently, a high proportion of applied N would be nitrate by this time.

If an N form was applied in the spring that has more rapid nitrification than anhydrous ammonia (urea, ammonium sulfate, ammonium in manure) or contains part of the N in the nitrate form (ammonium nitrate or urea-ammonium nitrate solution – UAN 28 or 32 percent), then conversion to nitrate would be faster.

Conversely, if an ammonium-containing fertilizer (anhydrous ammonia, urea or ammonium sulfate) or manure was applied shortly before a wet period, then loss would be negligible because little nitrification to nitrate would have occurred because nitrification does not occur in saturated soils and will not resume until soils dry and become aerobic.

Conversion to nitrate does not equal loss; it just means the N is susceptible to loss. Rapid and large losses occur only with excess leaching (predominant concern with sandy/coarse-textured soils) or with saturated soils (predominant concern with heavier textured, poorly drained soils).

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