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## Nitrogen loss: How does it happen?

John E. Sawyer

Iowa State University, jsawyer@iastate.edu

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# Nitrogen loss: How does it happen?

## **Abstract**

For the period April 1 through May 6, 2007, much of Iowa received more than 5 inches of rainfall (May 6, 2007 AWIS Inc. report). The Northwest, North-Central, and East-Central districts averaged slightly less than 5 inches, and the West-Central and Southwest districts more than 9 inches. With the large rainfall and flooding conditions, many producers are wondering about nitrogen (N) losses. While this period certainly has an influence on N in the soil, excessively wet conditions later in the spring are especially important for N losses. Early to mid-June will be a critical period to assess crop growth and needed N applications.

## **Keywords**

Agronomy

## **Disciplines**

Agricultural Science | Agriculture | Agronomy and Crop Sciences

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## Nitrogen loss: How does it happen?

*by John Sawyer, Department of Agronomy*

For the period April 1 through May 6, 2007, much of Iowa received more than 5 inches of rainfall (May 6, 2007 AWIS Inc. report). The Northwest, North-Central, and East-Central districts averaged slightly less than 5 inches, and the West-Central and Southwest districts more than 9 inches. With the large rainfall and flooding conditions, many producers are wondering about nitrogen (N) losses. While this period certainly has an influence on N in the soil, excessively wet conditions later in the spring are especially important for N losses. Early to mid-June will be a critical period to assess crop growth and needed N applications.

### Nitrogen Processing in Soil

If applied N or mineralized organic matter N (conversion from organic to ammonium) would stay in the ammonium (NH<sub>4</sub><sup>+</sup>) 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<sub>3</sub><sup>-</sup>) 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 and soil moisture (only occurs when soils are saturated--anaerobic conditions). 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 must therefore take into consideration the following factors: (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

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where it may form ponds or spill over stream banks into floodplains.



*Field areas with ponded water showing corn yellowing from wet soils and N deficiency.  
(John Sawyer)*

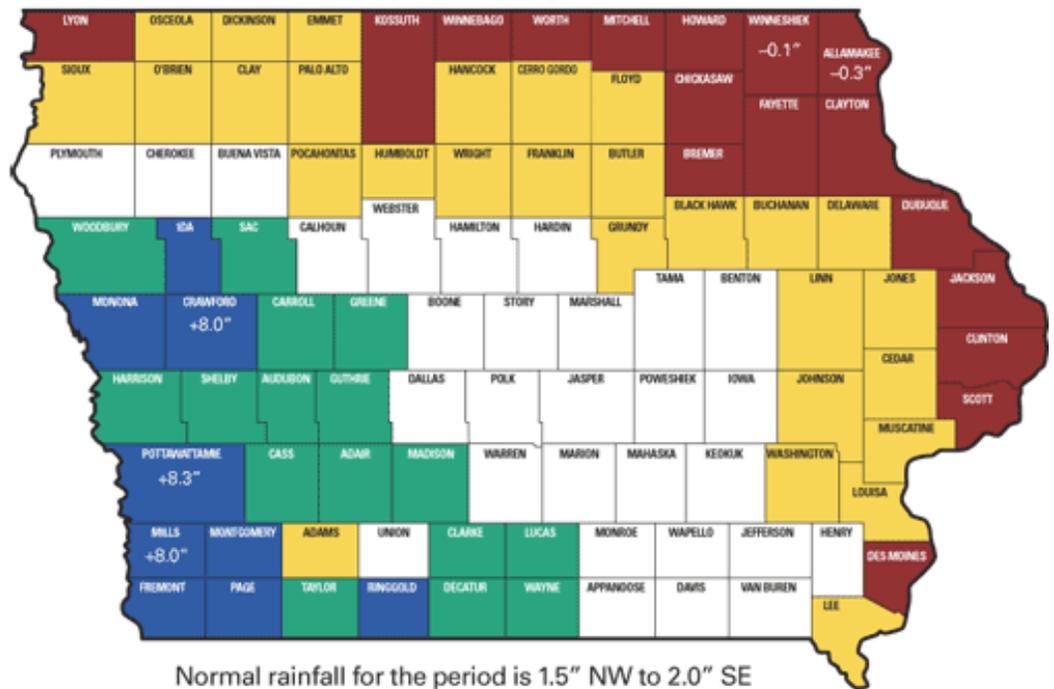
A highly important consideration is the conversion to nitrate. In Iowa, a substantial amount of anhydrous ammonia and manure is fall applied. Running the computer simulation model "Fate of Anhydrous Ammonia in Iowa Soils," developed at Iowa State University by R. J. Killorn and S. E. Taylor, indicates that in a warmer-than-normal scenario, and with ammonia applied either October 1 or November 1, all 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 35 percent for October 1 application and 50 percent for November 1 application). With an April 1 application and average spring temperatures, by May 1, approximately 50 percent would still be ammonium and by June 1, 10 percent would remain as ammonium (with N-Serve, 70 percent remaining as ammonium on May 1).

This information indicates that fall and early spring N applications have been at risk. If an N form was applied 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%), then conversion would be faster and more N would be present as nitrate.

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 (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. 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).

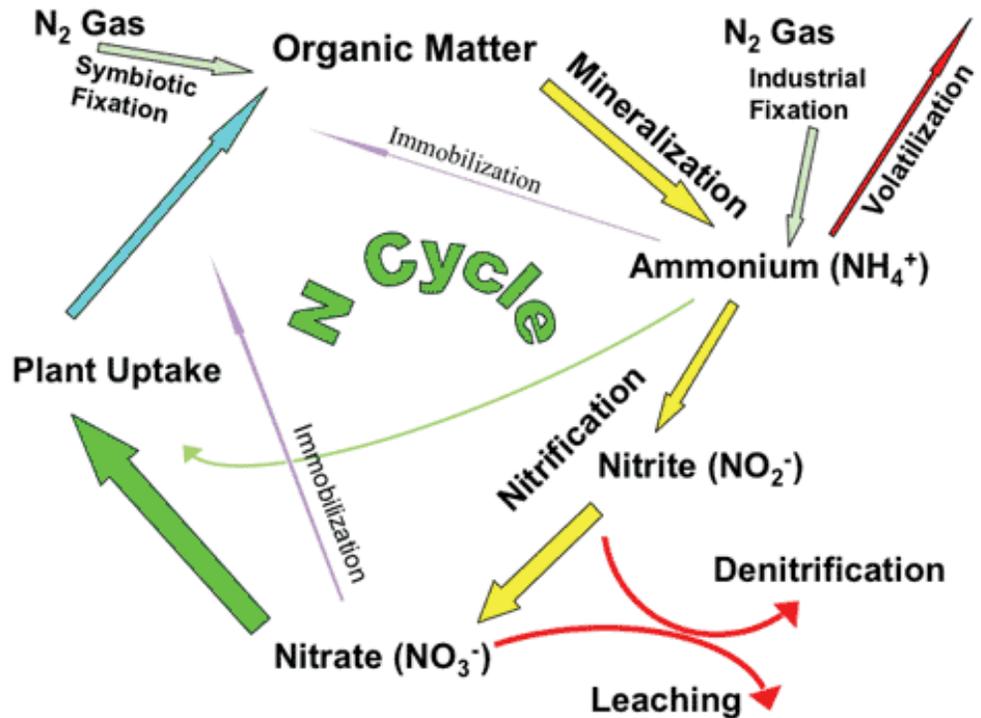
## Precipitation Departure from Normal April 22–May 7, 2007



Normal rainfall for the period is 1.5" NW to 2.0" SE

■ +7" or more   
 ■ +5" to +7"   
 ■ +3" to +5"   
 ■ +1" to +3"   
 ■ +1" or less

*Source: State Climatologist, Iowa Department of Agriculture and Land Stewardship*



*Simplified soil nitrogen cycle.*

*John Sawyer is an associate professor with research and extension responsibilities in soil fertility and nutrient management.*

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