ESTIMATING NITROGEN LOSS AND APPLYING ADDITIONAL NITROGEN

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Many areas of central to southern Iowa have experienced well above normal rainfall this spring, with several large rainfall events (see map). In the early spring, cold soils help reduce potential for nitrate-N loss due to slow accumulation of nitrate and slow denitrification. However, continued wet soil conditions into June with warm soils, prolonged saturation, and tile drainage enhance nitrate loss.

One way to determine nitrogen (N) loss is to calculate an estimate. Predicting the exact amount is quite difficult as many factors affect losses. However, estimates can provide guidance for supplemental N applications.

Research Measurement of Nitrate-N Loss

Research conducted in Illinois[†] indicated approximately 4 to 5 percent loss of nitrate-N by denitrification per day that soils were saturated. An all-nitrate fertilizer was applied when corn was in the V1 to V3 growth stage (late May to early June). Soils were brought to field capacity and then an excess 4 inches of water (above ambient rainfall) was applied by irrigation evenly over a 3-day period (which maintained saturated soils for 3 to 4 days on the finer textured soils) or an excess of 6 inches of water was applied over an 8-day period (which saturated soils an additional 3 to 4 days).

The excess water application resulted in loss of 60 to 70 lb N/acre on silt loam and clay loam soils, due to denitrification loss. On a very coarse-textured, sandy soil, virtually all nitrate-N was moved out of the root zone by leaching. On the finer textured soils, an addition of 50 lb N/acre after the excess water was sufficient to increase corn yields to approximately the same level where no excess water was applied. This was not the case on the sandy soil because considerably more N was lost due to leaching.

Nitrate loss via tile drainage does increase with above normal rainfall. At the Gilmore City, Iowa ag-drainage research site where tile-flow nitrate has been monitored since 1990, nitrate loss is greatest in years with higher precipitation and hence greater tile flow. At N fertilization rates of 150 to 160 lb N/acre, the annual nitrate-N loss per acre was 52 lb in the 1990-1993 period, 9 lb in the 1994-1999 period, and 39 lb in the 2000-2004 period (average nitrate-N losses for the combined corn-soybean sequence). The range in yearly nitrate-N loss for the years studied was 1.0 lb nitrate-N/acre in 1997 to 75 lb nitrate-N/acre in 1990.

Typically a high portion of tile flow and associated nitrate-N loss occurs in the springtime. The impact of excess precipitation on potential for nitrate remaining in the soil for crop use in wet springs like this year is that more nitrate-N is lost via tile flow, and overall the annual loss would be in the range of perhaps twice the “normal” loss amount, increasing from around 15-25 lb N/acre to 40-50 lb N/acre.

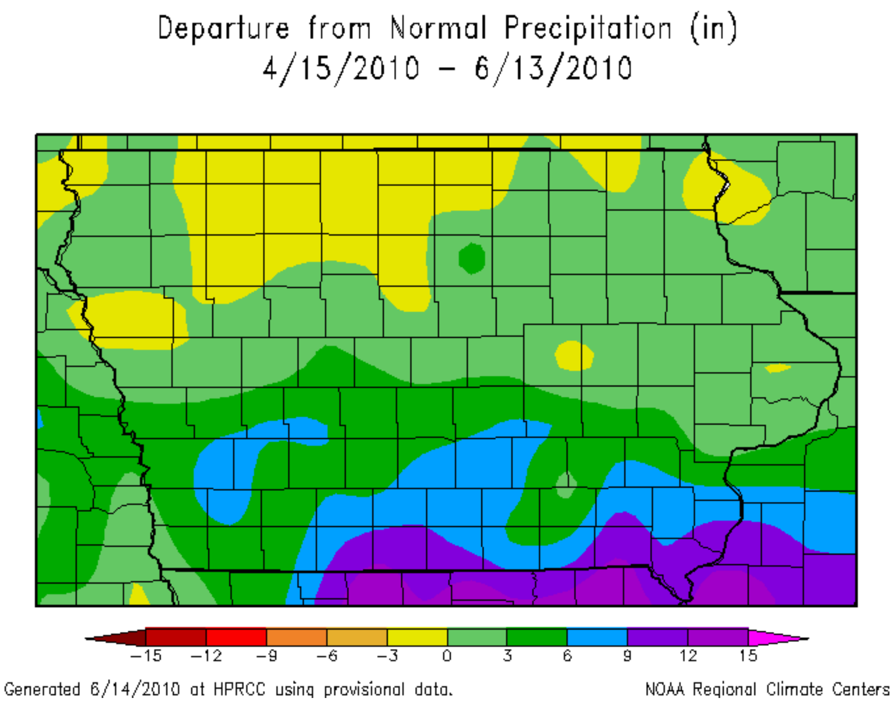
Estimating Nitrate-N Loss
According to research at the University of Nebraska, the estimated denitrification loss of nitrate when the soil temperature is 55 to 60 degrees F is 10 percent when soil is saturated for 5 days and 25 percent when saturated for 10 days (2 to 2.5 percent per day). Loss increases with warmer soils. Research conducted in Illinois with late May to early June (soil temperatures greater than 65 degrees F) with excess application of water on silt loam and clay loam soils indicated approximately 4 to 5 percent loss of nitrate present per day that soils were saturated.

To estimate N loss, the first step is to estimate the amount of ammonium converted to nitrate-N. By now, one might assume late fall anhydrous ammonia and manure ammonium to be nearly converted to nitrate, and with early April preplant N applications, much more than 50 percent converted to nitrate. Less conversion to nitrate would occur with use of a nitrification inhibitor. Recent ammonium applications (within the last two weeks) would still be predominantly in the ammonium form, especially for anhydrous ammonia. Recent application of nitrate-containing fertilizers would result in more nitrate being present. Urea-ammonium nitrate solutions (28 or 32 percent UAN) contain one-quarter nitrate-N, and nitrify more rapidly. The second step is to estimate the percentage of nitrate-N loss as described in the research above. The amount of N loss is calculated from these two estimates.

Example
The following might be an example of a situation with a spring preplant application of UAN solution and the wet conditions encountered this year. If 85 percent of a 120 lb N application is converted to nitrate, and soils were then saturated for ten days when warm, the N loss estimate would be (120 lb N per acre x 85% nitrate/100) x (4% per day/100) x (10 days) = 40 lb N per acre. Add in increased tile flow on tile-drained fields, and the loss estimate could be 60 lb N per acre. Variation of lower or higher losses could easily occur depending on warmer or cooler conditions, different forms of applied N, more or less time from N application to wet conditions and more or less time and frequency soils are saturated. The same will occur for different landscape positions and soils. With very coarse-textured/sandy soils, significant rainfall events (4 to 6 inches or more) in addition to already moist soils could easily result in all nitrate leaching out of the crop rooting zone.

Applying Additional Nitrogen
When conventional application equipment can be moved through the field (i.e., the soils are dry enough and the corn is short enough), then injection of anhydrous ammonia or UAN solutions would top the list of best options. Next would come urea-ammonium nitrate solution (UAN) surface dribbled between corn rows, and then broadcast urea. Broadcast UAN solution should be avoided on corn larger than the V7 growth stage. With tall corn, supplemental UAN will need to be applied with high-clearance equipment. Injection coulters or drop tubes between every other row or every row should work equally well. Urea can be broadcast with buggy or high clearance dry box spreaders if they can be driven between corn rows, or aerially applied. For broadcast urea, use of a urease inhibitor can help slow volatile N loss from warm wet soils as they dry. A urease inhibitor would not be needed with injected UAN, and low probability of need with surface dribbled UAN due to limited UAN surface contact with soil. With broadcast urea, some

material will fall into the plant whorls, but will cause only cosmetic damage to leaf tissue. That will show as spots or streaks when the leaf grows out of the whorl. Of course to get benefit from surface applied N it needs to be moved into the root zone with rainfall.



Precipitation departure map for the past two months in Iowa from the High Plains Regional Climate Center, Applied Climate Information System (http://www.hprcc.unl.edu/maps/).

† Reported in the 1993 Iowa State University Integrated Crop Management Conference proceedings, pp. 75–89, and in Torbert et al., 1993, "Short-term excess water impact on corn yield and nitrogen recovery," Journal of Production Agriculture 6:337–344.