ESTIMATING NITROGEN LOSSES

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Some areas of Iowa have recently received heavy rainfall, resulting in soils saturated or with standing water. Following are excerpts from an article published in 2011 when similar conditions occurred. The early spring 2014 season was on the cold side, so conversion of ammonium fertilizers to nitrate should have been slower than normal. This could be helpful for avoidance of nitrate losses, as would recent sidedress application of ammonium containing fertilizers. However, wet soils in June are much more conducive to nitrate loss (compared to early spring) as soils are warm; and with prolonged saturation and tile flow losses mount. Remember, ammonium is held on the soil exchange complex, but nitrate can leach or be denitrified to nitrogen (N) gasses. Also remember that corn plants do not respond well to saturated soils, and therefore can express symptoms similar to N deficiency when they really are showing excess water stress.

One way to determine 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 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 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 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 could assume late fall anhydrous ammonia and manure ammonium to be nearly converted to nitrate, and with early April preplant N applications a majority 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 95 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 95% nitrate/100) x (4% per day/100) x (10 days) = 45 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.

**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.*