AGRONOMIC Spotlight
Technology Development by MONSANTO

Assessing Nitrogen Loss after Soil Saturation

Nitrogen (N) loss is a major concern after soils have become saturated from heavy rainfall. Denitrification (microbial conversion of nitrate to nitrogen gases) and leaching are the processes involved with saturated soils that can result in significant N loss. Estimating N loss is not an exact science; however, below are some guidelines that can help with N assessment.

Nitrogen Loss

Denitrification. This occurs under anaerobic (lack of soil oxygen) soil conditions. Nitrogen in the ammonium-N form (NH_4^+) is not subject to denitrification or leaching. Loss can occur rapidly if nitrate-N is present, soils are saturated or flooded, and soil temperatures are > 50 °F. Studies conducted in Illinois showed that up to 5% nitrate-N loss through denitrification occurred each day soils were saturated. In these studies, all-nitrate fertilizer was applied when corn was in the V1 to V3 growth stage. Urea converts to nitrate quicker than anhydrous ammonia; approximately 2 weeks and 4 weeks, respectively. University of Nebraska data (Table 1) demonstrates the potential nitrate-N loss for every day of saturation at various temperatures. The potential for N loss due to denitrification increases rapidly as soil temperature increases.

Leaching. This is more of a potential concern with sandy soils, which allow rapid downward movement of water, well drained soils, and soils with improved drainage that allow rapid downward movement of water out of the rooting zone or out of the field completely. Ammonium nitrate and urea ammonium nitrate (UAN) solutions are more susceptible to leaching than anhydrous ammonia, with differences due to the rate of conversion to nitrate. Once fertilizer N is converted to nitrate, there will be no difference in the behavior of N in the soil profile between any sources of fertilizer N.

Table 1. Estimated denitrification losses as influenced by soil temperature and days of saturation.

Soil Temperature (°F)	Days Saturated	Nitrate-N loss (% of Total N Applied)
55-60	5	10
	10	25
75-80	3	60
	5	75
	7	85
	9	95

Source: Adapted from Nutrient Management for Agronomic Crops in Nebraska (R. Ferguson).

Estimating Nitrogen Loss

1. Calculate N present as nitrate:
   (N applied multiplied by % in nitrate form).
2. Calculate N denitrified:
   (lbs nitrate/acre from Step 1 multiplied by % denitrified from Table 1.

Note that the conversion to nitrate occurs almost immediately with N applied as urea. With 28%, half of the N is in the urea form, 25% is found as ammonium, and the remaining 25% as nitrate. The nitrate is already subject to loss, and the other fractions are readily converted. Conversion of N applied as anhydrous ammonia is delayed 10 to 14 days following application, regardless of any stabilizer added.

Soil temperature has a large influence on conversion of ammonium to nitrate. It takes approximately 2 weeks for complete conversion at 60 °F and 1 week is needed at 70 °F.

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Is Supplemental Nitrogen Necessary?

Applications of supplemental nitrogen may be warranted if sufficient loss has occurred. Amount of N loss is hard to quantify, as it depends on several factors, including soil type, soil temperature, form of N, and days of saturation.

One method to determine if supplemental N is required is the pre-sidedress nitrogen test (PSNT). PSNT soil samples should be collected to a depth of one foot when corn is between 6 and 12 inches tall.

Another measurement method involves calculating loss based on the amount of N applied without an inhibitor, yield potential, 5-year field yield average, days of soil saturation, and previous crop.

Management

If significant N has been lost, then more N should probably be applied via sidedressing. UAN liquid solutions can be applied as a band on the surface with drops, even on fairly large corn. For maximum effectiveness, rainfall or irrigation is required to move UAN and urea into the soil. Up to 30% of the urea could be lost due to volatilization if no rainfall occurs within two weeks and temperatures are warm.

Having adequate N for corn is critical for optimizing yield potential. Purdue University provides general recommendations by N form, timing of N application prior to excessive rain, and soil type (Table 2).

Assessing N loss and needs is not an exact science, but it can help provide estimates that impact your bottomline.

Table 2. Estimated nitrogen applications to replace lost nitrogen, based on nitrogen form and timing of nitrogen prior to excessive rain.*

Field Scenario	Fields where urea or 28% UAN was applied more than 2 weeks prior to rains. Also, where anhydrous ammonia was applied more than 4 weeks prior to excessive rain.	Fields where urea or 28% UAN was applied 1 to 2 weeks prior to rains. Also, where anhydrous ammonia was applied 3 to 4 weeks prior to excessive rain.	Fields where N loss is estimated to be less than 30 lbs N/acre and the projected optimum N rate or higher was used initially. Fields where N was applied 2 to 7 days (urea or 28%) or 3 weeks (anhydrous ammonia) before excessive rain.
Should I Apply Nitrogen?	Additional N Likely Required	Additional N *May Be* Required	Additional N Likely NOT Required
What Rate of Nitrogen?	Consider 60 to 120 lbs N/acre	Consider 30 to 60 lbs N/acre	Likely None

Source: Adapted from J. Camberato, et al. Nitrogen Loss in Wet and Wetter Fields. 2008. Purdue University. 13 June 2008. Online at http://www.agry.purdue.edu (3/10/2010)
**For more specific recommendations based on soil type, reference the above-cited document from Purdue University.*

Sources: R. Ferguson. Part 1, Fertility Principles. Nutrient Management for Agronomic Crops in Nebraska. University of Nebraska. http://cropwatch.unl.edu (3/10/10).

R. Hoeft. Predicting and Measuring Nitrogen Loss. The Bulletin: pest management and crop development information for Illinois. No. 10, Article 8, May 28, 2004. http://www.ipm.uiuc.edu (3/10/10).