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Nitrogen and Sulfur Leaching Potential in Virginia

Mark S. Reiter[1,2] and Wade E. Thomason[1]
[1]Eastern Shore Agricultural Research and Extension Center, Virginia Tech
[2]Department of Crop and Soil Environmental Sciences, Virginia Tech

Early summer often means locally heavy and sporadic rainfall as thunderstorms deliver intense rains, and 2015 appears to be no different with many areas in eastern Virginia receiving 3+ inches of rain in a few days (Figure 1). These storms also often coincide with the timing of sidedress nitrogen (N) and sulfur (S) applications on corn. While some rainfall after sidedress is very beneficial to facilitate N movement into soil, heavy rain (2+ inches) often leaves us wondering how much, if any, of that recently-applied N remains and if additional N is needed.

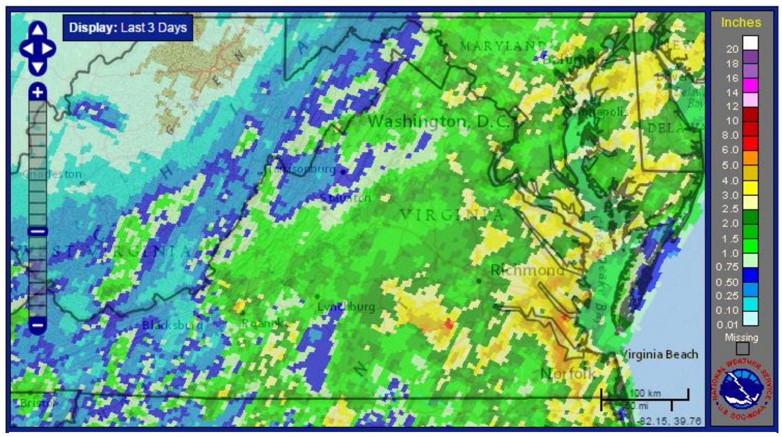

Figure 1. Three day rainfall total for Virginia (June 1-3, 2015) (NOAA-National Weather Service, 2015).

First, the N fertilizer we apply is water soluble so the portion that remains on leaves, residue and the soil surface is subject to runoff with heavy rains. Second, saturated or ponded soils typically undergo anaerobic conditions resulting in denitrification. The losses under saturated conditions occur quickly, within a few hours, but at this time of year those losses are typically small and in the range of 5 to 10 lbs. N/ac. However, denitrification rates will increase as soil warms and/or soil remains saturated (>5 days). In Virginia, we typically do not see an entire field undergo significant denitrification, but you may see this problem in “wet spots” that have extended durations of soil saturation. Third, the nitrate portion of fertilizer sources is subject to leaching in soils with sand textures; which is the predominant soil texture in eastern Virginia.

The majority of sidedress N on corn is applied as urea-ammonium nitrate liquid (UAN); which derives approximately 50% of fertilizer N from urea and 50% from ammonium nitrate (IPNI, 2015). Liquid UAN is a water-soluble fertilizer salt with the nitrate portion (~25% of total N) available immediately for plant uptake and leaching susceptibility. However, it takes a few days to a week for the remainder of the fertilizer to undergo biochemical reactions once applied to become plant available – think about the time it takes for a crop to ‘green-up’ after N application as a reference. Once these reactions occur, the fertilizer will be broken into ammonium, which is not generally subject to leaching losses, and nitrate which does readily leach. Over time, soil microbes will convert all fertilizer N to the nitrate form; with this conversion speed depending on your specific soil temperature, moisture, and pH.

The degree of nitrate leaching depends on the amount of water moving through the soil, how much of that water is moving below the root zone, and the total amount of nitrate present. Recent work in Maryland highlights the "risk" of nitrate leaching based on the "exchange frequency index" (EFI) (Forrestal et al., 2014). The EFI value is based on the available water holding capacity of a soil (an estimate by soil texture) and the amount of rainfall that has occurred. They define an EFI of less than 1.5 as low to moderate risk of leaching and greater than 1.5 EFI as a high risk of leaching. So for example, let's say you have corn planted on a sandy loam textured soil in eastern Virginia; which has a typical water holding capacity of 1.25 to 1.40 inches per foot of soil (Figure 2). At knee-high, corn roots have a maximum depth of about 10-inches. Based on the figure 2 table values, a 2.0 inch rain event on a sandy loam soil would give you an EFI of 1.6. The EFI is calculated by dividing the 2.0 inch rainfall event by the 1.25 inches of water per foot from sandy loam soils. This particular field therefore had a high potential of leaching since the EFI was greater than 1.5. Alternatively, a 1.5 inch rain event would result in a low to moderate risk of leaching since the calculated EFI is 1.2. However, remember that the amount of your total fertilizer N applied might not yet be all nitrate since UAN is a mixed fertilizer source.

Textural class	*Water holding capacity, inches/foot of soil*
Coarse sand	0.25 - 0.75
Fine sand	0.75 - 1.00
Loamy sand	1.10 - 1.20
Sandy loam	1.25 - 1.40
Fine sandy loam	1.50 - 2.00
Silt loam	2.00 - 2.50
Silty clay loam	1.80 - 2.00
Silty clay	1.50- 1.70
Clay	1.20 - 1.50

Figure 2. Soil water holding capacity by soil textural class (UNCE, 2015).

So, in this example of a 2-inch rainfall event it is likely that significant nitrate leaching could have occurred for sandy loam soils and that additional N application should be considered. How much (if any) additional N is needed will be based on site-specific conditions for each field. Losses will likely be highest in instances where sidedress occurred within a few days of heavy rainfall, on the coarsest textured soils, and with higher total N rates. Losses up to 25% of the total sidedress rate have been documented, though losses are often less. For producers that placed all of their N out at-planting or before, losses may be substantially higher as the plant did not have time to take up the N and most of the soil fertilizer was likely converted to the nitrate (leachable) form by microbes prior to the rainfall. Splitting N between a minimum of two applications at different corn grown stages (at-planting and knee-high) is always best.

Similar to N, S is a mobile nutrient in the soil system. Sulfur sources to plants are from fertilizer, air emissions, and by being released from soil organic matter. In cool and wet springs, sulfur may be deficient to young corn plants as soil organic matter cycling is low and sulfates (the plant available form of sulfur) may have leached below the plants' effective root zone. Sulfur may especially appear deficient on soils that are coarse textured and low in organic matter; which is common in the coastal plain.

There are several in-season techniques for monitoring crop N and S status, including the pre-sidedress soil nitrate test (PSNT), plant tissue testing, etc., that can be implemented to make the best informed decisions in cases where unknown fertilizer losses have occurred. Many private labs can email or fax results back within a day or two after sample submission. For around $10 for soil and $25 for plant tissue, tests will give exact nutrient concentrations and pinpoint what nutrients may be in short supply. Soil nitrate tests should be taken from several portions of the field to a depth of 12-inches. Plant tissue tests for corn less than 12-inches tall should be taken from the aboveground plant from 30 different plants across the entire field. Between 12 inches tall and tassel, sample the upper-most fully developed leaf (leaf has a "collar"). Overall, the time and money it takes to test your corn is small compared to the fertilizer inputs you have already or will potentially invest.

Nitrogen and S corrections can be made if deficient throughout the season with data showing that applications as late as tassel may be beneficial for crop yield. However, farmers should note that "feeding the soil" is the safest and most efficient way to supply N and S nutrition to plants. While foliar feed fertilizers are available, it is difficult to supply sufficient N or S fertility to the corn crop and with foliar feeds you always run the risk of leaf injury. For more information on proper fertilizer use and placement in field corn and PSNT, consult Virginia Cooperative Extension publications #424-027 (Nitrogen and Phosphorus Fertilization of Corn) and #418-016 (Nitrogen Soil Testing for Corn in Virginia).

References

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