Nitrogen Availability From Soil Organic Matter, Fertilizer, and Amendments

or...Are you getting your money's worth from your fertility practices?

by Doug Collins, WSU Extension Small Farm Team, Puyallup, WA

Organic & Mineral Nitrogen

There are two broad categories of nitrogen (N) in the soil—organic nitrogen and mineral nitrogen.

Organic nitrogen includes that which is part of organic matter, e.g. in plant tissues, the solids in manure, or in a seed or feather-meal fertilizer. On a chemical level, this N is bound to carbon (C). Organic soil nitrogen is bound to carbon in proteins (amino acids), amino sugars, or other complex nitrogen compounds.

Mineral nitrogen is not chemically bound to carbon, is soluble, and available for plant uptake.

The two most important forms of mineral nitrogen in soil are ammonium and nitrate. These are the forms of nitrogen that plants can take up, and most plants get the majority of their nitrogen from nitrate uptake. So, even if synthetic fertilizer is not applied, plants are still dependent on there being nitrate available in the soil. The trick to nitrogen management is to make sure that nitrate is available at the right time and in the right amount. This can be accomplished in a variety of ways; via synthetic or organic fertilizers, cover crops, and/or through the native fertility of soils.

N Availability

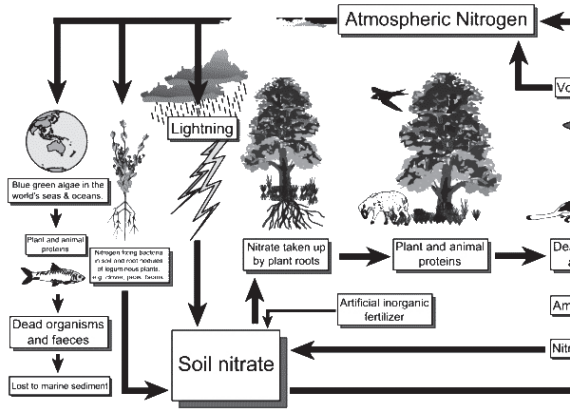
The type of organic fertilizer applied makes a big difference as to when mineral nitrogen will be available. Mineral nitrogen is made available from organic nitrogen through a process called mineralization.

The rate at which mineral nitrogen is made available from organic nitrogen depends on soil temperature, soil moisture, soil aeration, and the carbon to nitrogen ratio (C–N) of residues.

Here are some practical examples of how much mineral nitrogen (including nitrate) would be available in the soil after a season, based on mineralization rates for western Washington and Oregon. [1]

1. Apply 1 ton/acre of a 4-4-4 fertilizer (4% N, 4% phosphate (P), 4% potash (K)). About 41 pounds/acre of mineral nitrogen would be available through the season.
Total N applied = 80lbs/acre;
mineralization rate = 51%
2. Apply 10 ton/acre composted dairy manure (1.5-0.5-0.5). About 30 pounds/acre of mineral nitrogen would be available through the season.

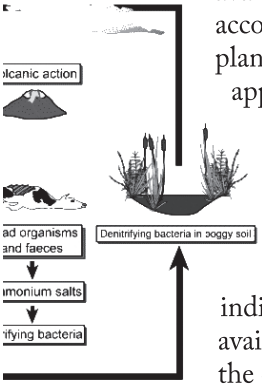
The Nitrogen Cycle



Total N applied = 300 lbs/acre;
mineralization rate = 10%

Mineral nitrogen is made available from both the fertilizer and manure but more of it, on a percentage basis, is made available in the first year from the organic fertilizer.

One outcome of this is that the dairy manure will continue to supply mineral nitrogen in the following years, though not at the same rate. If a dairy manure slurry application yields 30 pounds/acre of mineral N in the first year, then one should count on receiving about 6, 5, and 4 pounds/acre in the first, second, and third years after that initial application, respectively. [2]



While this is a good thing for N availability, it should be accounted for in your fertility planning to ensure subsequent applications are adequate but don't waste resources and affect water quality.

Soil Testing

While a fall soil test will not directly indicate how much N will be available the following year, the organic matter value on a soil test will give you some indication of how much nitrogen will be mineralized through the season from the existing organic matter. [3]

This is nitrogen that should be accounted for separately from fertilizers or recently applied manures and composts. The amount of nitrogen made available from organic matter can be estimated from equation 1:

Equation 1: Estimated nitrogen release (lbs/acre) = percent organic matter x 49. [4]

For example, a soil with 3% organic matter can be estimated to yield 147 pounds of mineral nitrogen per season. This equation assumes a 2% mineralization rate, which is a "rule of thumb" for nitrogen mineralization from soil organic matter.

As mentioned previous, mineralization is dependent on many different factors. More site-specific mineralization rates can be determined by establishing a "zero N plot" in the field and sampling crop tissue. 5

Nitrogen to be applied per management unit can now be calculated from equation 2:

Equation 2: N to be applied = (plant N requirement) – (N mineralized from organic matter).

Online Help

OSU developed a great online Organic Fertilizer and Cover Crop Calculator to help you make these calculations quickly, easily and accurately. The URL is listed below.

Endnotes

1 OSU Organic Fertilizer and Cover Crop Calculator [online] http://smallfarms.oregonstate.edu/calculator

2 Endelman et al., 2010. A new decay series for organic crop production. Agronomy Journal, 102: 457-463.

3 Gaskell, M., R. Smith, J. Mitchell, S. T. Koike, C. Fouche, T. Hartz, W. Horwath, L. Jackson. 2007. Soil fertility management for organic crops. University of California Division of Agriculture and Natural Resources. Publication 7249.

4 Assumes organic matter is composed of 7% nitrogen, 2% annual mineralization rate, and that one acre of soil to a depth of 1 foot weighs 3,500,000 pounds.

5 Sullivan, D.M., J.P.G. McQueen, and D.A. Horneck. 2008. Estimating nitrogen mineralization in organic potato production. Oregon State University. EM 8949-E.