Changes in Soil Nitrate-N Levels from Late Summer to Early Spring in Montana

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Introduction

Most soil sampling is conducted from August to November in Montana because of better soil sampling conditions and because it provides more time for growers to make fertilizer decisions prior to application. Fertilizer guidelines in Montana are based on spring nitrate-nitrogen (nitrate-N) levels (in the upper 2 feet) because they are more indicative of growing season available N than fall nitrate-N levels. It is not known how much nitrate-N levels change between late summer and spring, nor what factors affect these changes. Large changes could result in either over- or under-application of N fertilizer. Over-application is an economic loss and excess nitrate may contaminate groundwater. Under-application may cause sub-optimal yields and grain protein. Our goal was to predict nitrate-N changes based on previous crop, soil characteristics, and weather conditions to enable producers to adjust their N rates based on fall soil sampling.

Methods

We measured soil nitrate levels in the upper 2 feet (if rocks allowed) in late summer, mid fall, and early spring in Bozeman and at each of the seven Montana State University Agricultural Research Centers over three years, beginning in August 2007. Soil samples were collected following four previous crop types (annual legume, fallow, oilseed and cereal grain) and several soil characteristics (organic matter, pH, soil texture and soil water content in the upper 6 and 6-24 inches; nitrate-N, Olsen phosphorus, exchangeable potassium and cation exchange capacity in the upper 6 inches) were measured at each sampling location.

Results

Late summer and fall to spring nitrate changes were highly variable and we found very little correlation between soil characteristics and nitrate changes. Most soils gained nitrate from late summer to spring, with most of those gains occurring from August to November. Fresh residues and warm soils in late summer and fall would encourage plant decomposition leading to increased available N. Generally there was less nitrate gained from November to April, especially in soils less than 24-inches deep (data not shown). Shallow soils may have gained less nitrate either because there was less organic N to become available over a smaller depth or these soils were more prone to losses, such as leaching. Soils with higher initial nitrate levels also tended to have lower overall nitrate gains from August to April, likely because more nitrate was available to be lost (to leaching, atmospheric losses, or microbial tie-up). In other words, high residual nitrate in late summer does not necessarily carry over to the following spring. If nitrate isn't used by plants in a

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growing season, it may be lost from the system over winter. On average, there were gains on deeper soils with less initial nitrate and better chance for losses on shallow ground with high initial nitrate.

Prior crop influenced late summer to early spring nitrate changes ($P<0.10$). Generally, nitrate levels increased more from August to April following broadleaf crops (annual legume and oilseed) than following cereal grains or fallow (Figure 1). Higher overwinter N credits should likely be given after broadleaf crops than after fallow or cereal grains. On average, November samples more closely represented April nitrate levels regardless of the prior crop (Figure 2).

August to April changes in soil nitrate levels ranged from losses of 55 lb N/acre to gains of 64 lb N/acre. November to April soil nitrate changes ranged from losses of 86 lb N/acre to gains of 66 lb N/acre. These large ranges suggest that late summer or fall soil samples may not accurately estimate spring soil nitrate and thus determine spring fertilization rates. August and April soil nitrate levels were different by more than 20 lb N/acre in 54% of samples, while November and April soil nitrate levels were different by more than 20 lb N/acre in 38% of samples. Basing spring fertilizer rates on August through November soil samples could lead to spring fertilizer wasted or yield and grain protein compromised.

Fertilizer Facts:

- On average, late fall soil samples should better estimate the following growing season's N availability than late summer samples.
- Generally late summer to spring nitrate changes are greater following broadleaves than following cereals or fallow.
- If fall nitrate levels are very high and soil depth is less than 2 feet, a second sampling in spring is recommended because there is a higher likelihood of overwinter nitrate losses.
- Based on our study, N fertilizer would be over-applied by an average of 18 lb N/acre if August samples were used to make spring N recommendations. One in three times, it would be under-applied, and sometimes by a substantial amount, especially when August nitrate levels are high or soils are shallow.

For more information on this study see the MFAC Final Report, Jan 2011, under 'Newsletters and Reports' at http://landresources.montana.edu/soilfertility/.

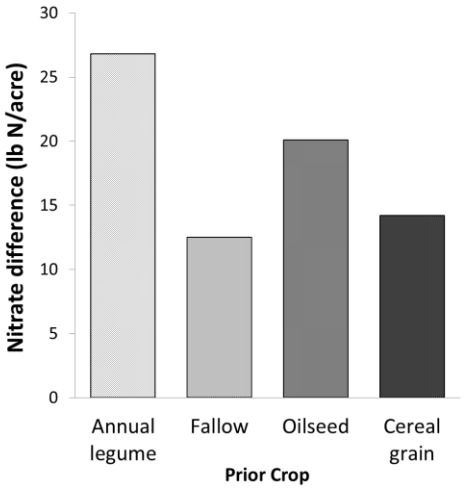

Figure 1. Change in soil nitrate-N from August/early September to April for each prior crop averaged across 8 sites and 3 years.

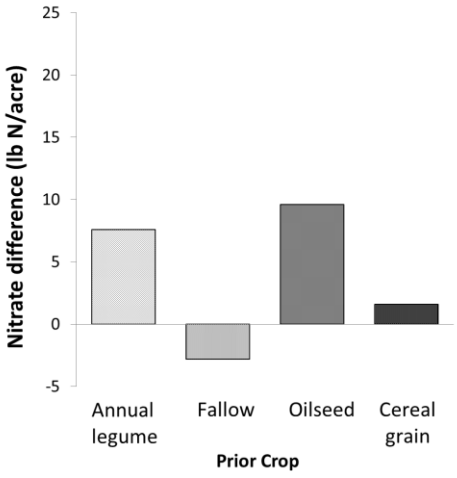

Figure 2. Change in soil nitrate-N from November to April for each prior crop averaged across 8 sites and 3 years.

Edited by Clain Jones, Extension Soil Fertility Specialist, and Kathrin Olson-Rutz, Research Associate