Nitrate Leaching

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Nitrate leaching is a health and economic concern in agricultural areas throughout Montana. There are several agronomic practices available to minimize nitrate leaching.

Nitrate comes from fertilizer or decomposition of organic matter and manure. It is highly soluble and easily lost to leaching (movement below root zone) as water moves through the soil. Sandy or shallow soils have higher leaching potential than clay, loam or deep soils. Irrigated fields have higher leaching potential than dryland cropping. Irrigation should be managed to meet the crop need, but not exceed the soil's ability to hold water ("field capacity"). Dryland systems are susceptible to leaching when fall, winter or early spring rains exceed field capacity, since there is little water by plants during these periods.

In dryland cropping systems, reducing fallow is likely the best option to reduce downward water movement and nitrate leaching, since fallow fields have no crop in place to take up water or nitrate. Replacing fallow with annual legumes ("pulses") such as field pea can substantially reduce nitrate leaching. In addition to using soil water, annual legumes are good scavengers of available nitrogen and need little or no nitrogen fertilizer. Cover crops can catch nitrogen in systems with high nitrogen inputs and extended overwinter/early spring bare periods (e.g., corn, sugarbeets, home or market gardens).

Fall-planted crops are ideal following fallow to take up some nitrogen before spring rains. Perennials or deep rooted annuals use water and nitrogen that may escape shallow rooted crops. While alfalfa is an excellent scavenger of soil nitrate, the large supply of nitrogen remaining after alfalfa is terminated can release nitrate. To avoid leaching loss of this nitrate, fields should be recropped rather than fallowed after alfalfa termination, and credit the N contribution from alfalfa in fertilizer nitrogen rate calculations to avoid over fertilization. Increasing annual crop diversity and including perennials is more important in tilled than no-till systems.

Annual soil testing and realistic yield goals help avoid over-fertilization. Ideally, conventional nitrogen fertilizer is applied from seedling to late tillering stages in cereal grains and seedling to early branching in oilseeds. Fertilizer topdress applications should be timed based on plant demand or growth stage. By matching nitrogen rates to plant needs and using split applications, there is less risk of left-over nitrogen in the soil. Nitrogen release from legume crop residue better matches the timing of crop growth and nitrogen uptake than conventional nitrogen fertilizer and results in less nitrogen leaching.

Often, most nitrate leaching comes from only a fraction of the total area of a field. Areas of a field that are limited by factors other than nitrogen should receive just enough nitrogen to meet that area's production potential. A deficiency in soil water or other nutrients, such as phosphorus, potassium, or sulfur, can result in less crop growth, less water uptake and more nitrogen left in the ground, demonstrating the importance of soil testing and variable rate nitrogen application to reduce leaching.

Many agronomic management practices can be used to minimize nitrogen leaching losses and potential groundwater contamination. The Montana State University soil fertility extension website (http://landresources.montana.edu/soilfertility/) has resources to help calculate fertilizer rates and a Soil Scoop with more detailed information on nitrogen leaching.