Management Practices to Minimize Nitrate Leaching

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Today’s Goals

Discuss:

• soil factors that increase nitrate leaching potential
• crop management practices to minimize leaching
• fertilizer management to minimize leaching
Soil factors that increase leaching

- Soils with large pores
- Soils with cracks or vertical channels that connect surface to below root zone
- Shallow soils
### Water and Soil

**Plant available water holding capacity for various soil textures**

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Inches Water per Inch Soil</th>
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</thead>
<tbody>
<tr>
<td>Sand, fine sand</td>
<td>0.06</td>
</tr>
<tr>
<td>Loamy sand</td>
<td>0.08</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>0.12</td>
</tr>
<tr>
<td>Loam, silt loam silt, sandy clay, silty clay, clay</td>
<td>0.17</td>
</tr>
<tr>
<td>Sandy clay loam, clay loam, silty clay loam</td>
<td>0.18</td>
</tr>
</tbody>
</table>

$$(0.12 \times 12) + (0.18 \times 24) = 5.8$$ inches water to refill soil to 3 ft depth

More precipitation or irrigation could leach nitrate
Manage irrigation

- Irrigate to meet crops' needs but not exceed soil's ability to hold water
- Sprinkler systems allow better control than furrow or flood
Regional changes in soil nitrate from November to April in top 2 feet of soil

Jones unpubl data.
Averaged over 4 previous crops at each research station.
Crop management factors to decrease N leaching

- Know your soil and yield potential for proper N management
- Recrop rather than fallow
- Reduce tillage
- Diversify to include perennial and/or deep rooted crops
- Consider legumes since don’t need to fertilize w/ N
- Space crops for optimal yields to optimize resource use; ex. SW in 6” rows and 30 plants/ft² – Fertilizer Fact # 37
- Use variable rate technology
- Carefully manage irrigation
Long-term Effect of Cropping System on Soil Fertility

- 1983 to 2004 near Culbertson, MT
- Comparing tillage and crop
- Small-plot field trial
- Soil samples:
  - Collected in October 2004, 4-6 weeks after fall tillage
  - Taken to 8 inch depth
Tillage and Crop Combinations

- **NT-CW**: No Till-Continuous Spring Wheat
- **SpT-CW**: Spring Till-Continuous Sp. Wheat
- **FSpT-CW**: Fall & Spring Till – Continuous Sp. Wheat
- **FSpT-WB/P**: Fall & Spring Till – Wheat/Barley (17 years), Wheat/Pea (4 years)
- **SpT-WF**: Spring Till – Sp. Wheat/Fallow

All residue was left on the field
Estimated N loss
Spring 1983 to Fall 2004

Culbertson, MT 2004, 20 year study
Sainju et al. 2009
N loss = Initial soil N + fertilizer N + surface residue N
- grain N - final soil N

WHY?

Economics?
Adding legume-perennial grass to the rotation

• 33 years of 6-yr rotation in SK on heavy clay soil
• Alfalfa/bromegrass hay-hay-hay-fallow-wheat-wheat
• No fertilization
• Soil sampled in 1991 at end of May and early Sept after harvest
Perennial forage reduces nitrate leaching compared to fallow-wheat

Rotation and Season

0-14 in soil
14-27 in

Hay plow-down in July

adapted from Campbell et al. 1994, SK
Inclusion of legumes

• Legumes are excellent N scavengers – will use much of what is in soil before ‘fix’ N
• Since legumes don’t need N fertilizer, this leaves less nitrate in soil, especially in dry year when crops don’t remove much
• Legume residues are similar to ‘slow release N fertilizers’ which can lower N fertilizer needs in long run
• Interrupt disease and insect cycles = fewer pest problems

Beware of herbicides with high persistence
N fertilizer management factors to decrease N leaching

- Soil test so don’t over-apply
- Apply in spring or slow release fertilizer in fall
- Time application as close to peak N uptake as possible
- Top dress between tillering and flowering in moist years
Overwinter N loss is greater when more is available to lose.

How much N leached at 120 lb spring fertilization rate?

Fall 2006 to Spring 2007

0-22 inch soil depth
Moccasin
Chen unpubl. data

N Fertilization Rate (lb N/acre)
How should I determine my fertilizer N rates?

Soil Test
  When??
  Spring is best
  Why??

Result if soil test too early: Fertilizing more or less than needed ($$)
Effect of previous crop and N on 2006 winter wheat grain yield (NT) 
Moccasin, MT

Note: There was good moisture in 2006

Data from C. Chen
Increasing N Fertilizer Use Efficiency

Enhanced Efficiency Fertilizers

Two major types:
  - slow release (ex: polymer coated or aldehyde bonded)
  - inhibitors (ex: alter soil processes)

Should you consider using them?
  - Yes: on warm season, irrigated crops
  - Maybe: on cool season, dryland crops

Downside-N release often occurs too late to match N uptake

Upside-can apply ~2 – 4x as much slow release product as conventional urea directly with the seed
EEFs and leaching

- Nitrogen use efficiency has been found to be 4 to 14% higher with CRU (Controlled Release Urea) than conventional urea. Improvement is likely due in part to reduced leaching.
- Watch for continued development of ‘new and improved’ products.
- See *Enhanced Efficiency Fertilizers* (EB0188) for more information.
  
  http://landresources.montana.edu/soilfertility/PDFbyformat/publication%20pdfs/Enhanced_Efficiency_Fert_EB0188.pdf
Reduction of potential N loss through split applications

Modified from HortTechnology. 9(4): 603.
Cumulative N uptake by spring wheat

Nutrient Uptake Timing by Crops: to assist with fertilizing decisions
http://landresources.montana.edu/soilfertility/publications.html
Summary

Nitrate leaching is affected by both natural and human factors. For example, leaching is increased by:

- Porous and shallow soils
- Higher precipitation
- Annual cropping rather than perennial forage
- Summer fallow
Summary:
Farming practices that reduce nitrate leaching

- Include perennial forage in rotation
- Recrop rather than fallow
- Reduce tillage
- Apply N in spring according to soil test
- Split N application to match plant needs or use EEFs
- Consider applying less N in areas that yield less or have shallower soils
Other Resources

- Soil Fertility information:
  http://landresources.montana.edu/soilfertility
Questions?