Management Practices to Minimize Nitrate-N Leaching on Shallow Soils

Extension Service and Montana Department of Agriculture Grower Workshop

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Is more of your land...

1. No Till
2. Minimum Till
3. Conventional Till
Is most of your land recrop or fallow?

1. Recrop
2. Fallow
Is more of your land...

1. Perennial Forages
2. Annual Crops
Do you apply N in fall, winter or spring?

1. Fall
2. Winter
3. Spring
4. Don’t apply N
Do you apply your N once per crop, or more than once per crop?

1. One time
2. More than once

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Nitrogen cycle

Nitrogen Fixation

$N_2(g)$

Plant Uptake

Nitrification

$NH_4^+$

Plant Uptake

Hydrolysis

Mineralization

Immobilization

Leaching

Exchange

$NO_3^-$

Nitrate (neg charge) doesn’t bind to neg charged soil
Soil factors that increase leaching

- Low SOM
- Soils with large pores
- Soils with cracks or vertical channels that connect surface to below root zone
- Shallow soils
What is the average depth of your soil (before you hit rocks, hardpan, or groundwater)?

1. less than 2 feet
2. 2 – 4 feet
3. greater than 4 feet
4. I don’t know

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0 of 5
Regional change in soil nitrate from August 2007 to April 2008 in top 2 feet of soil

What is causing most locations to have gains?

C. Chengi unpubl data.
Averaged over 4 previous crops at each research station.
Is spring nitrate always less than fall nitrate at Moccasin?

WHY?

Fall/winter precipitation

0-22 inch soil depth

Moccasin
Chen and Jones unpubl. data

2006 to 2007
11.6 inches

2008 to 2009
5.0 inches
Do you base your N rates on soil tests?

1. Yes
2. No

0 of 5
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 ($$)
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
- Select appropriate variety
- 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
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

N loss (lb/acre)

Why?
Not Avail
Economics?
Trend in acres of wheat-fallow

Dryland Wheat-Fallow Acreage (% Total Dryland)

Year

1999 2001 2003 2005 2007 2009

Fergus County

Judith Basin County
Winter wheat recrop yields as a percent of fallow yields

- **Fergus County**
- **Judith Basin County**

"economic break-even"
Does rotation affect potential for nitrate leaching?

- 6-yr rotation in SK, 2 cycles = 12 yrs
- Nitrate below 27 inches would have leached on a shallow soil
- 3 rotations
  - Fallow-W-W or F-W-mustard or F-W-canola
  - Diverse annual = rotation of pea, fall rye, wheat, barley, canola, flax, mustard
  - Diverse & alfalfa = canola or mustard-W-B-alfalfa-alfalfa hay-alfalfa hay
Diversify crop, add perennials to reduce N loss – Fall soil N

Malhi et al. in prep.  
6-yr rotations established in 1995  
Saskatchewan

October 27-40 inch Soil Nitrate-N

- Fallow-Wheat/Oilseed
- Diverse Annual
- Diverse & 3-yrs Alfalfa

Year and Growing Season Rainfall (in)
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
Do some small grain varieties remove more N than others?
Grain N Yield for Winter Wheat Variety Trials within 50 miles of Moccasin (2007 - 2009)
Net Revenue for Winter Wheat Varieties within 50 miles of Moccasin (2007-2009)

Winter wheat price = $6/bu
Protein discount = $0.08/0.25% protein
Urea = $360/ton
WINTER WHEAT VARIETIES

This is an interactive website. With your inputs below, you can generate a table of results relative to your geographic location.

You can narrow your selection criteria by using the OPTIONS below. Check as many as you like. Best results will be found by moving back and forth between this page and the results table (use your browser's back button).

Cultivars that continue to yield near the top over multiple years and locations (higher 'N' values) increases confidence for the potential of that cultivar.

Switch to Experiment Station Selection

Find results within: 50 miles of Moccasin

Choose a parameter: % Cut Stem

Choose year(s): 2009, 2006, 2005

Create Table

OPTIONS

- Cropping System: All, Dryland, Irrigated
- Market Class: All, Hard Red, Hard White
- Clearfield Type: All, No, Yes
- Limit by Cultivar Traits: All selected
- Solid Stem
- Straw Strength
- Winter Survival
- Maturity
- Coleoptile Length
- Leaf Spot
- Stem Rust
- Stripe Rust
- Dwarf Smut
- Milling Quality
- Baking Quality
- Limit By Environmental Parameters
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
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
Spring soil nitrate rates are all the same.
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/PDFs/EEF720.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
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

• Crop Variety Selection Tool:  
  http://sarc.montana.edu/php/varieties.php
Questions?