Nitrogen Management in Direct Seeding Operations

Golden Triangle January 3-4, 2011

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MONTANA STATE UNIVERSITY
EXTENSION

Objectives

- Discuss nitrogen fertilizer placement and timing to meet 2011 crop needs with a focus on in-row placement and top-dressing
- Show amounts of urea volatilization occurring in the Triangle
- Discuss ways to minimize volatilization

In-row Nitrogen (N) Placement

- Germination and emergence are impacted if N is applied too close to seed
- Sandy dry soils result in highest amounts of germination problems
- The rate of N fertilizer that can be applied increases as seed bed utilization (SBU) increases
- SBU = 100x(width of seed row/row spacing)
- Ex: Opener = 1 in. row spacing = 12 in. SBU = 100*(1/12) = 8%

Effects of SBU and Soil Moisture on Emergence

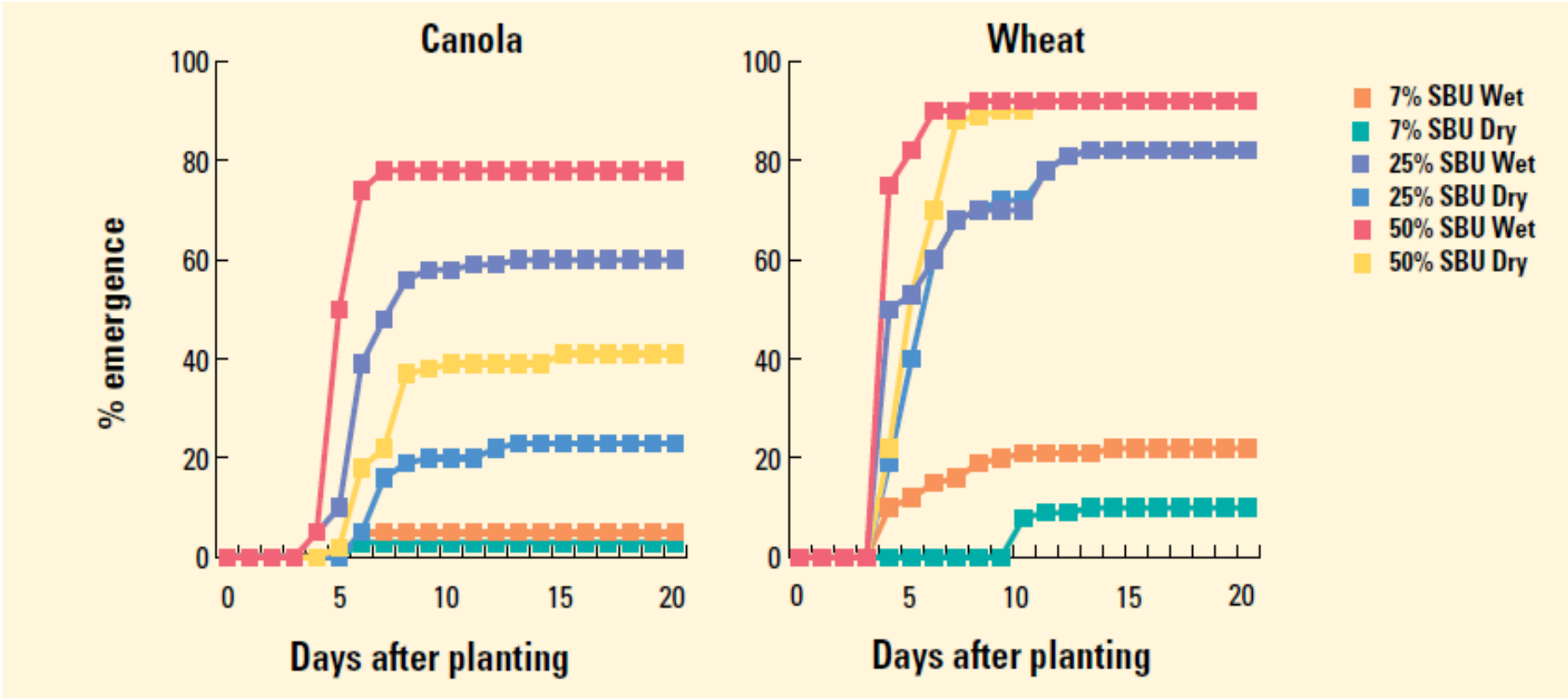


Figure 1. Seed-placed urea (60 lb N/A) reduces emergence under dry soil conditions and low SBU (Alberta data).

Robert and Harapiak. 1997. Better Crops. 81:17-20

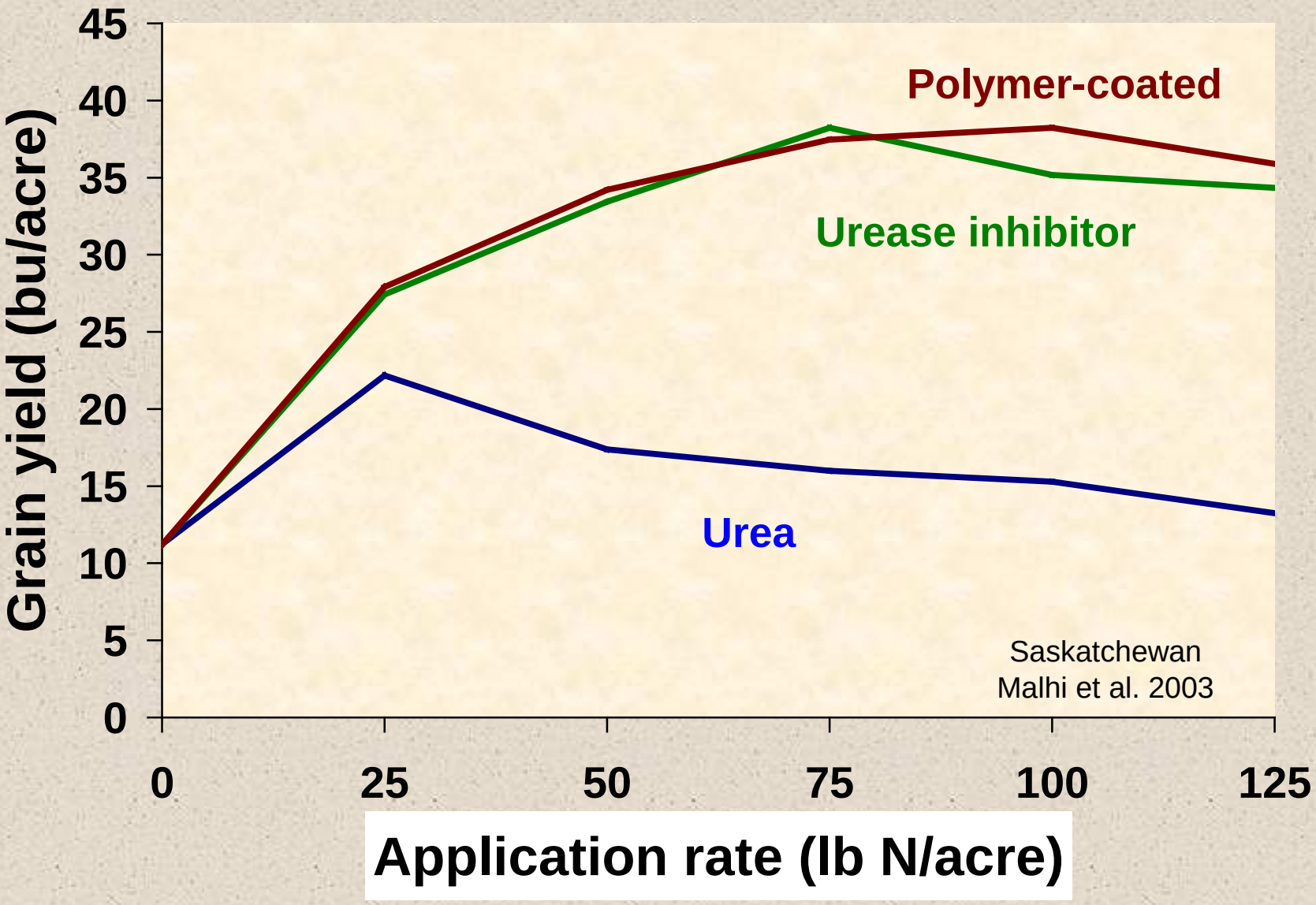
Safe rates of seed placed urea N

Approximate safe rates of urea N (lb N/acre) that can be applied with the seed of cereal grains.

	1 inch spread Row spacing		3 inch spread Row spacing	
Soil texture	**6”**	**12”**	**6”**	**12”**
Light (sandy loam)	20	15	40	25
Medium (loam to clay loam)	30	20	50	35
Heavy (clay to heavy clay)	35	30	60	40

Source: Roberts and Harapiak. 1997. Better Crops Vol. 18(2):18-20

Effect of N source applied with the seed on dryland spring wheat yield



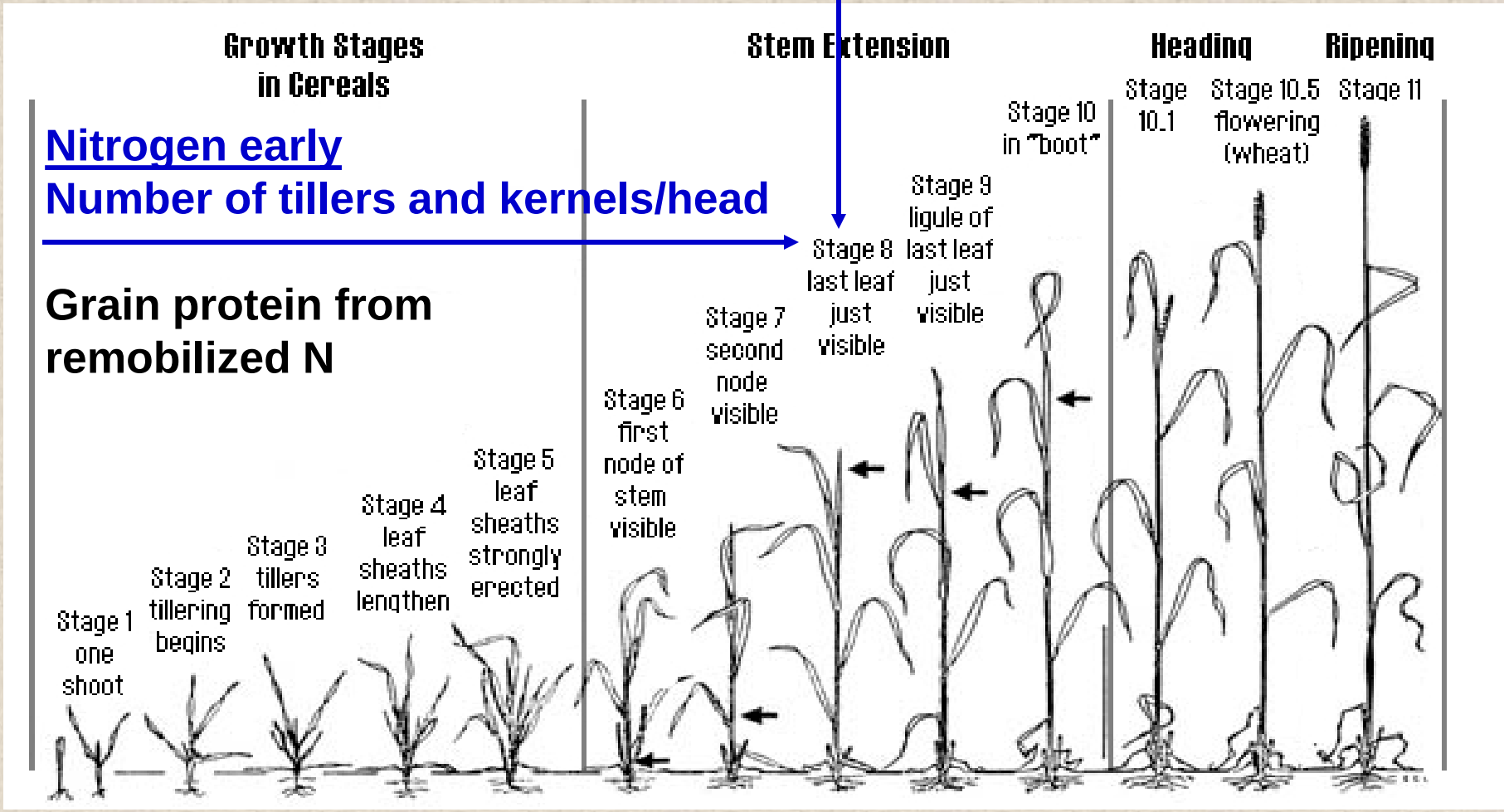
Topdressing and Split Applications

- How do I decide when to topdress if I don’t want to hurt yields and want to maximize protein?
- First need to know how much the plant needs and when it needs it.

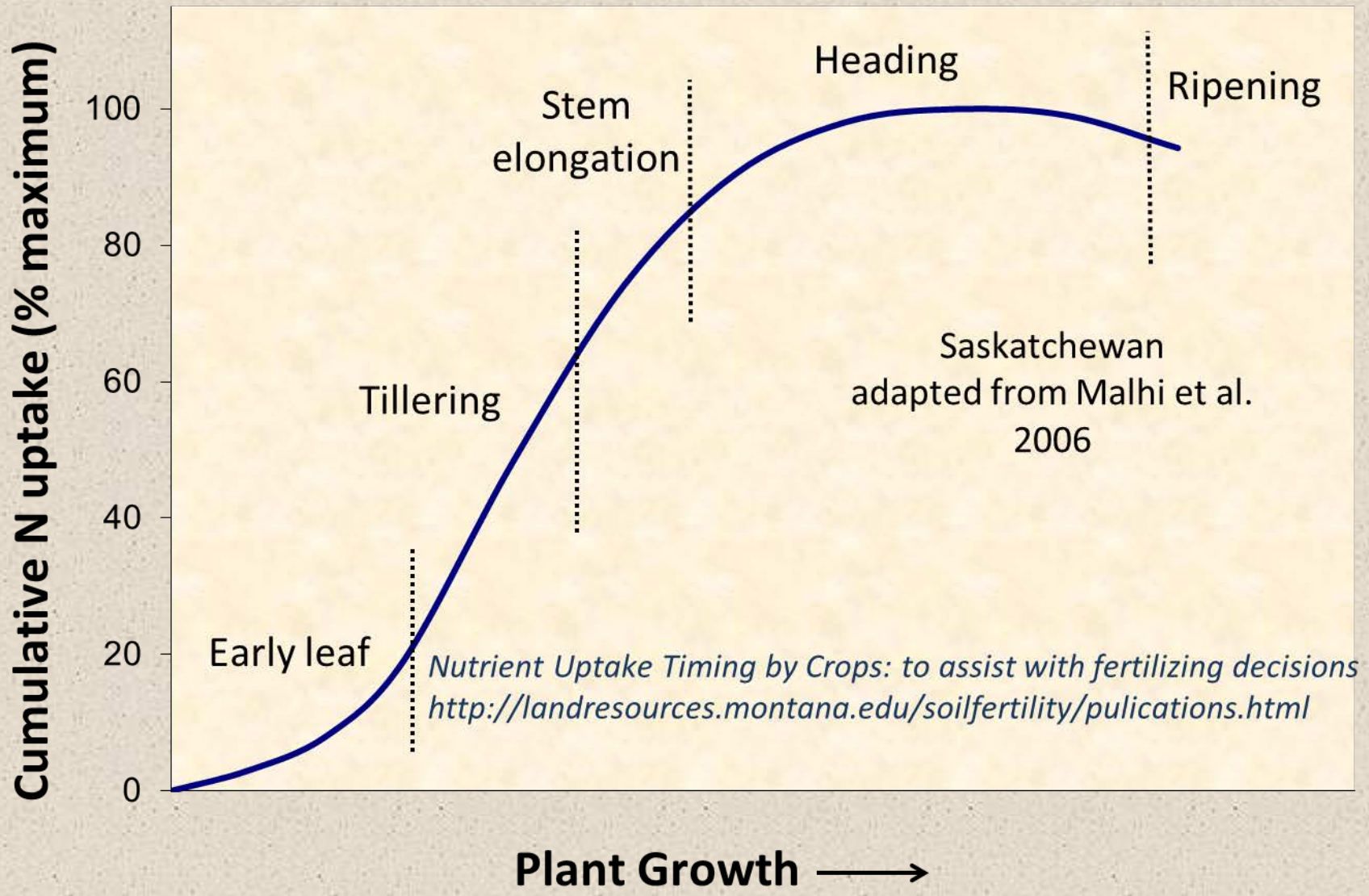
N application timing effects on yield and protein

Nitrogen late
Weight/kernel

Higher grain protein



Cumulative N uptake by wheat

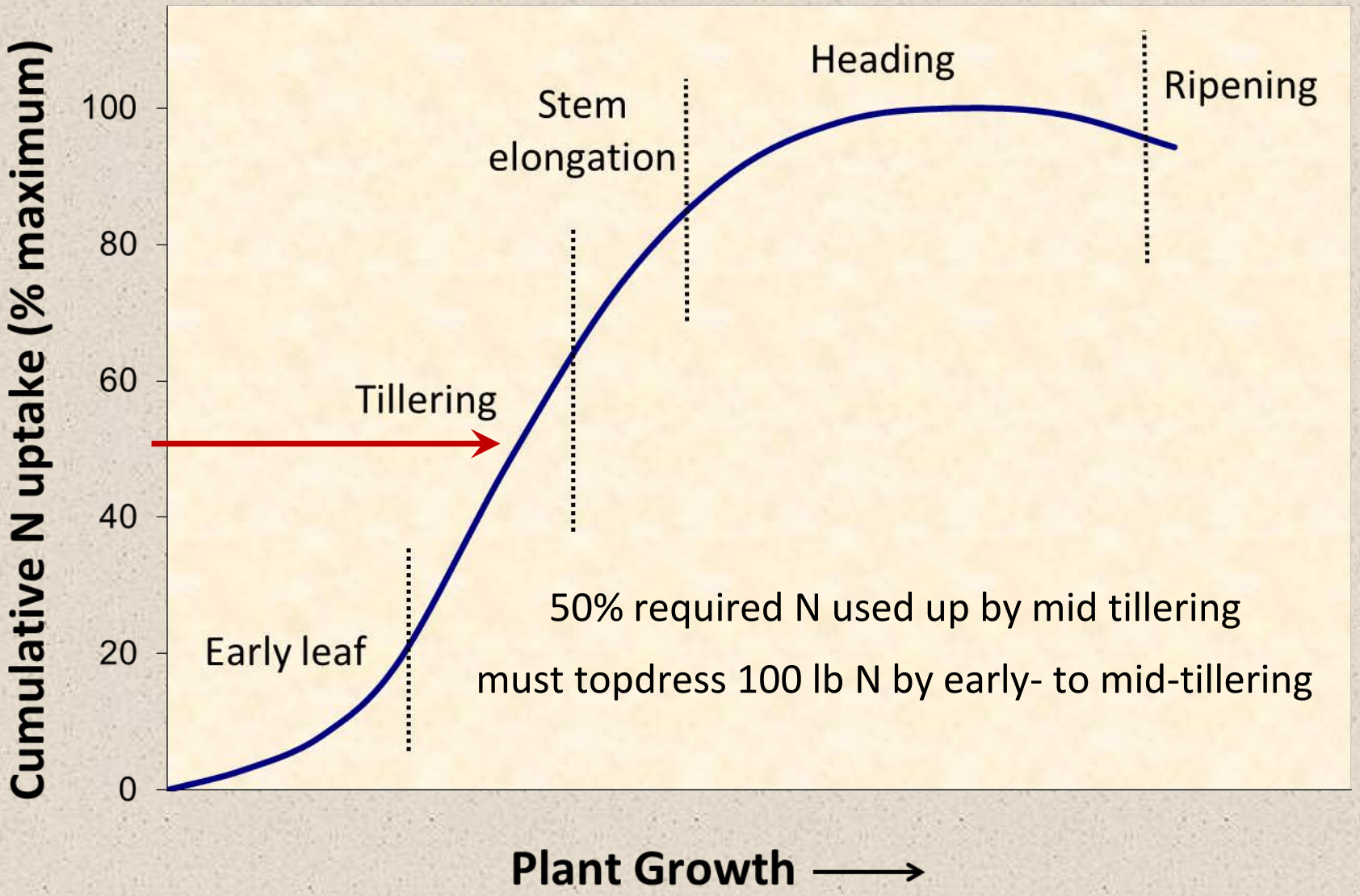


Use Nutrient Uptake figure to time top-dress

Example on per acre basis:

- 200 lb N total need, 40 lb N in soil, 60 lb preplant N
- soil and preplant supply 100 lb N = 50% total N required
- (200 – 100) = 100 lb N top-dress

Top-dress amount and timing based on plant growth stage

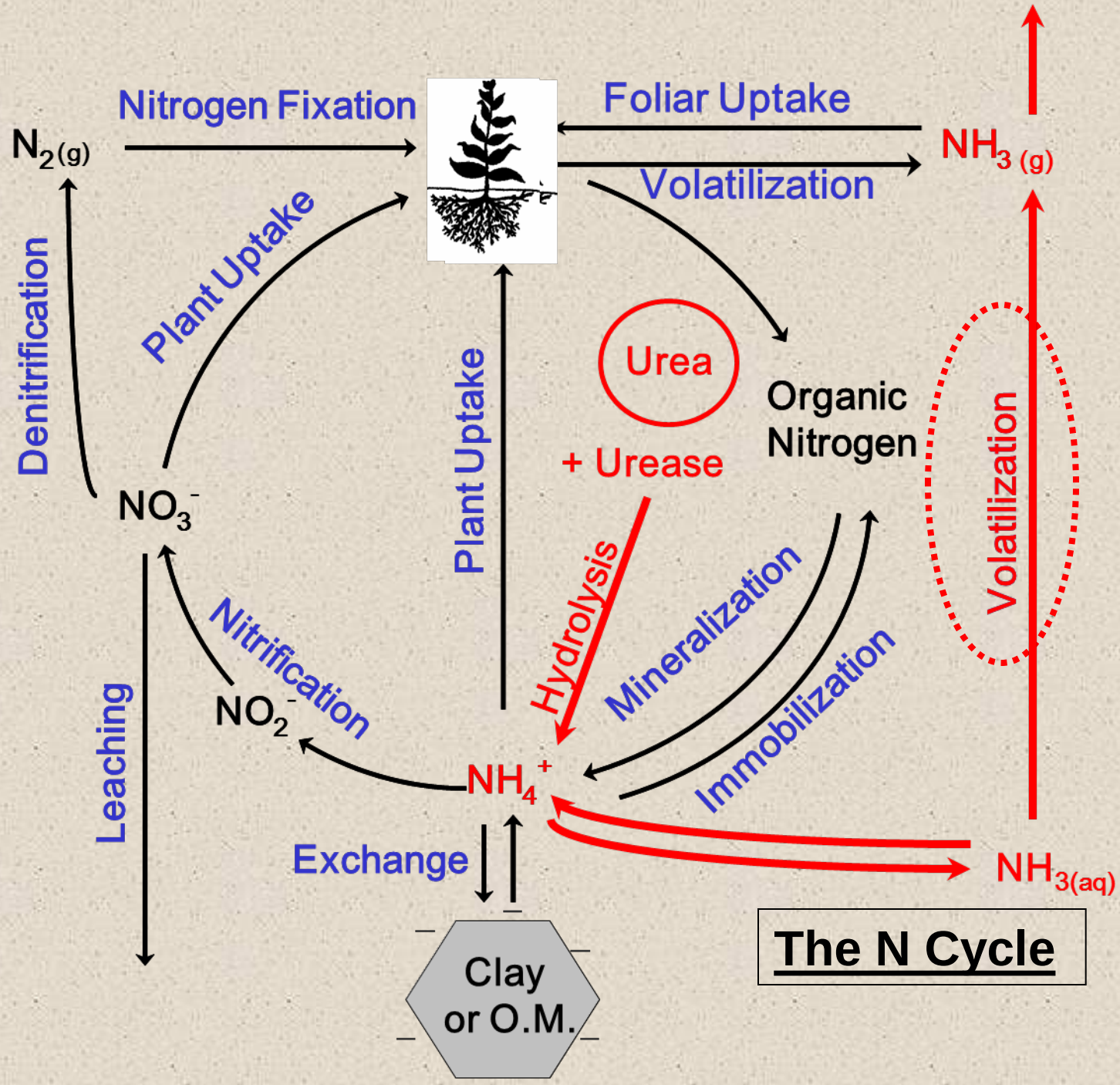


Foliar Applications

- Biggest advantage – can use a herbicide sprayer w/ only minimal stand damage
- Most foliar applied N ends up being washed off and taken up by roots:

  -Only 8-11% of foliar applied liquid urea was taken up by leaves, whereas 37-67% of soil applied N was taken up by plant in same study (Rawluk et al., 2000).
- Generally only about 20 lb N/ac can be applied on leaves without getting some burn. Though up to 60 lb N/ac have been applied without excessive burn.

Questions?

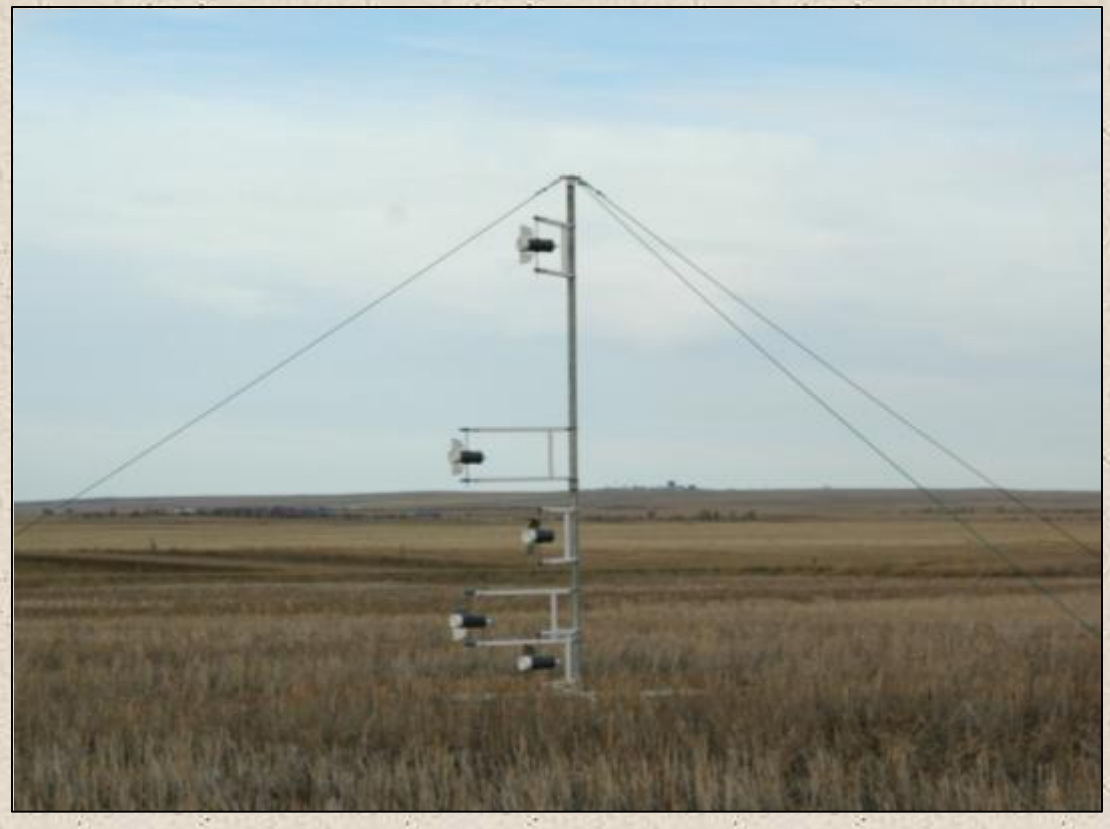

Nitrogen Fixation
$N_{2(g)}$
Foliar Uptake
$NH_{3\,(g)}$
Volatilization
Denitrification
Plant Uptake
Plant Uptake
Urea
+ Urease
Organic Nitrogen
Volatilization
NO_3^-
Hydrolysis
Mineralization
Immobilization
Nitrification
NO_2^-
Leaching
NH_4^+
Exchange
$NH_{3(aq)}$
Clay or O.M.
The N Cycle

Factors Increasing Volatilization

1. **High Soil pH and Temperature**
2. **Windy**
3. **Low Cation Exchange Capacity (CEC). WHY?**
4. **Low buffering capacity (resistance to pH change)**
5. **High soil moisture/humidity**
6. **Little Rainfall/Irrigation following fertilization**
7. **High Ground cover/vegetation/residue. WHY?**
8. **Low Soluble and Exchangeable Calcium**

Bottom line: Large number of factors make volatilization amounts VARIABLE and difficult to predict.

A first look at ammonia volatilization losses from surface-applied urea



Richard Engel, Clain Jones, Jeff Whitmus
Montana State University

Project Objectives

- How much N as ammonia are we losing from applications of surface urea (fall, winter, and early spring)?
- Is this a significant economic loss to Montana producer?
- If losses are significant, then how do we mitigate losses?

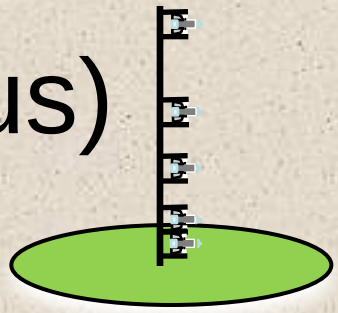
Integrated horizontal flux method

- preferred approach for quantifying gas loss
- moderate size plots (~0.3 acre)
- continuous measurement of $NH_{3(g)}$ loss over time

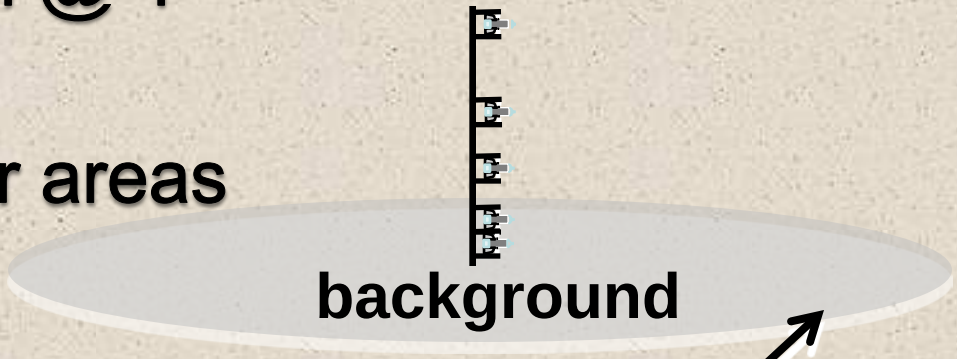
mast and shuttles ⇨

Circular plots (22 yard radius)

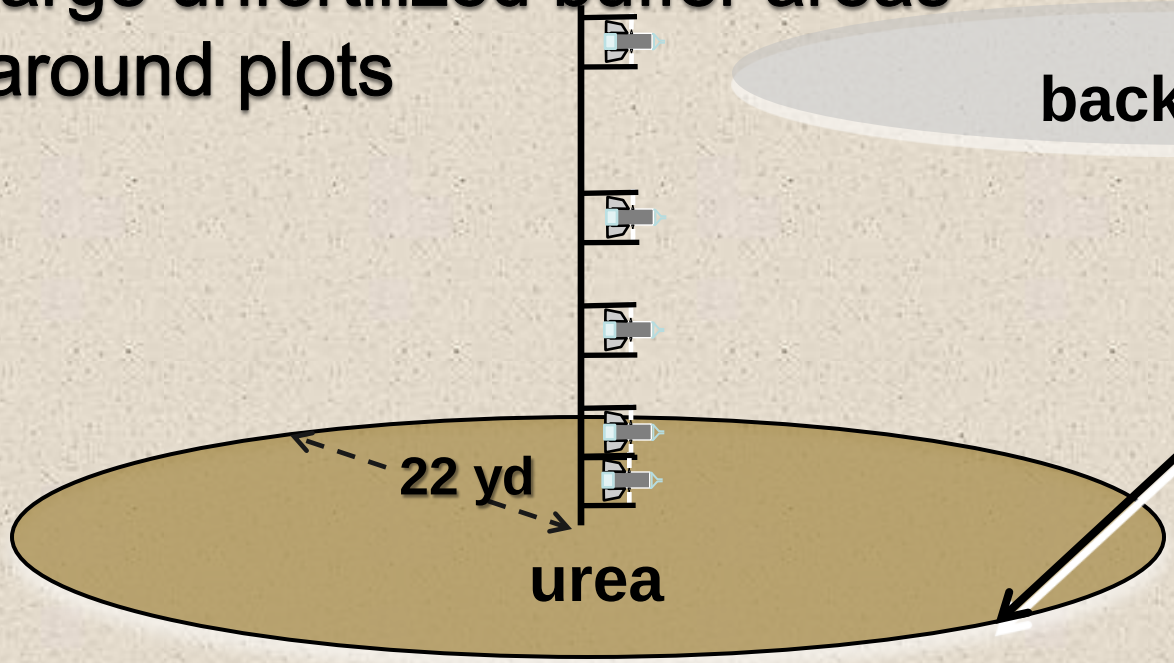
- urea (90 lbs N/acre)
- urea + NBPT (Agrotain @ 4 quarts/ton)
- large unfertilized buffer areas around plots



urea + NBPT

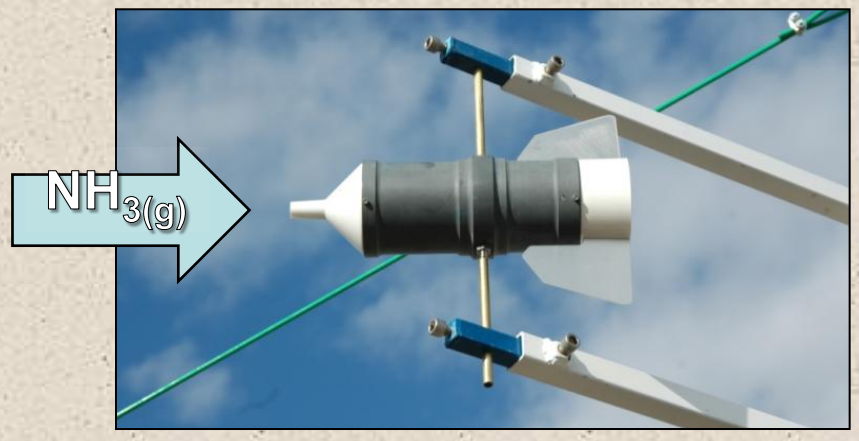


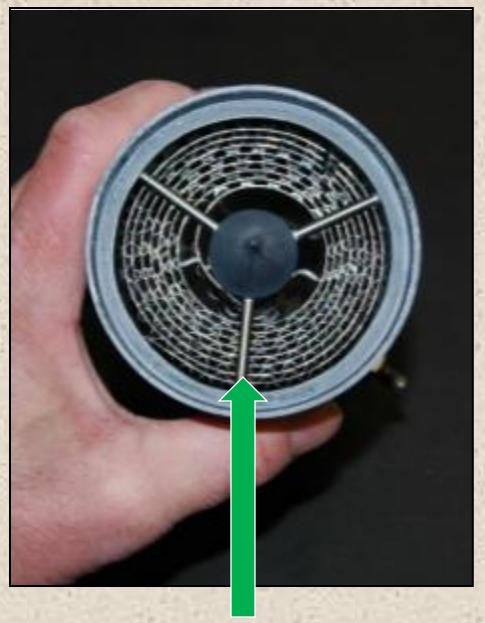
background



Shuttles

- traps for collecting ammonia





front

stainless steel spiral coated with oxalic acid

back

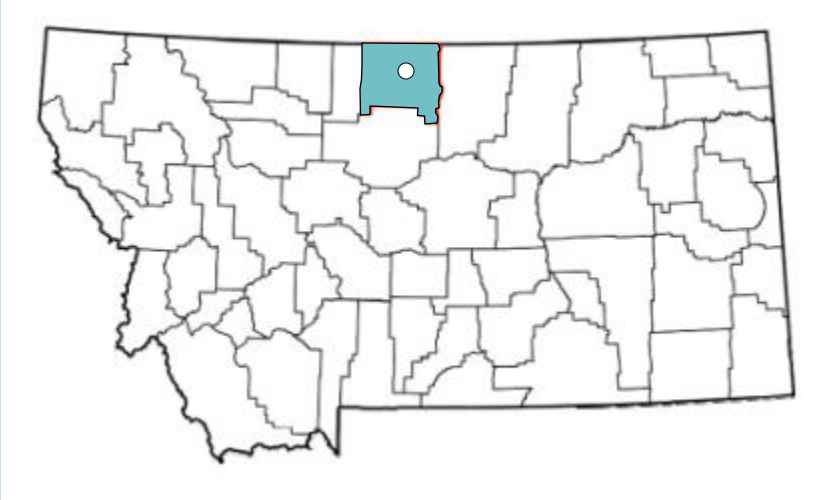
rotate on pivot & face into wind

Two examples of field trial results from west Havre field site (Kaercher farm)

- Hill County
- Phillips-Elloam silt loam
- pH 6.0
- no till winter wheat
- Campaigns 2 and 5 - conducted in the identical field

Campaign 2: October 9, 2008.
Air temp = 45 F, Soil temp = 43 F

Campaign 5: March 26, 2009. Air temp = 21 F, Soil temp = 34 F

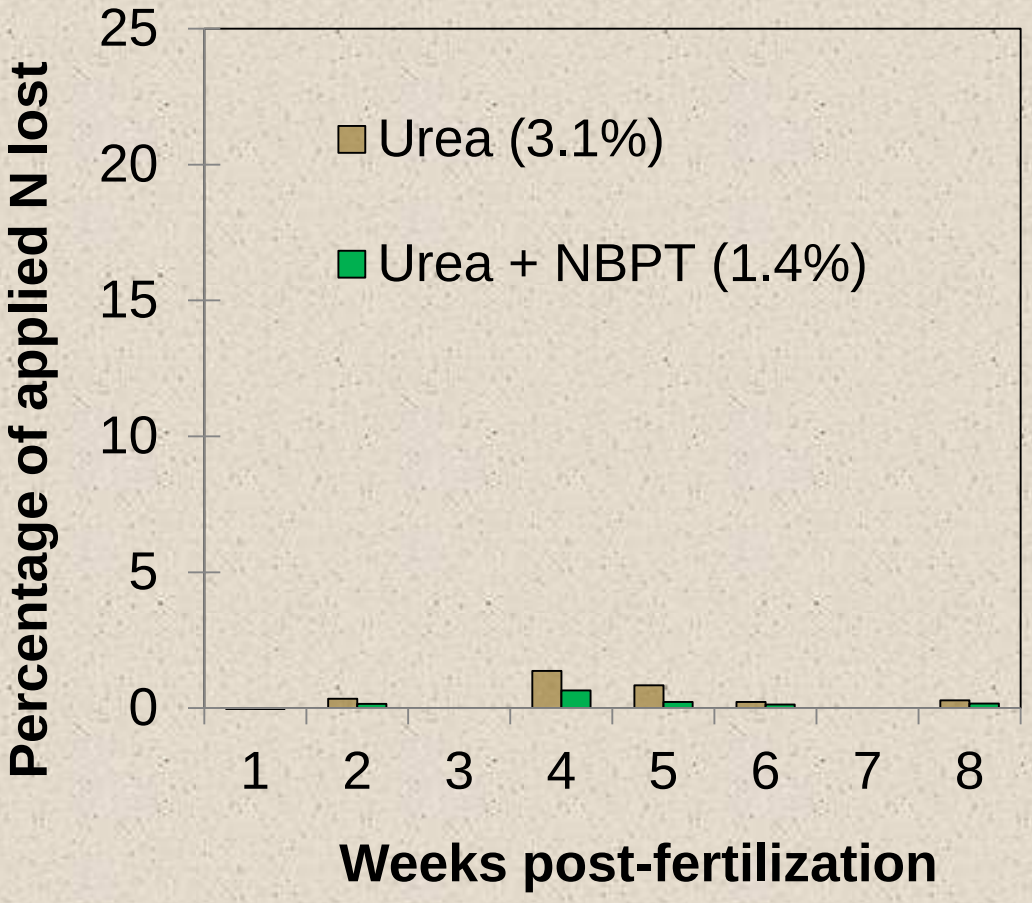


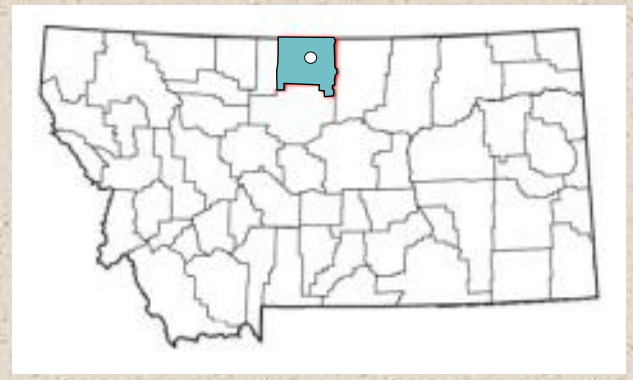
Campaign #2 – low NH_3 losses observed

- October 9, 2008 application, air-temp. 45 °F, dry soil surface
- no rain for 24 days and then Nov. 2-5 field site received 0.98”ppt.

1 wk post-fertilization
prills not dissolved

Campaign #2 - Kaercher farm

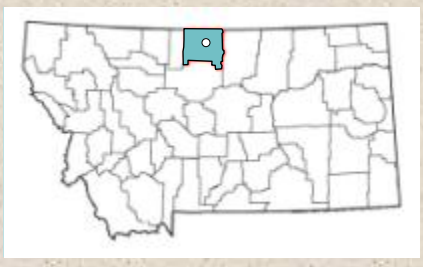




Mean Air Temp ~ 42 F

Mean Soil Temp ~ 41 F

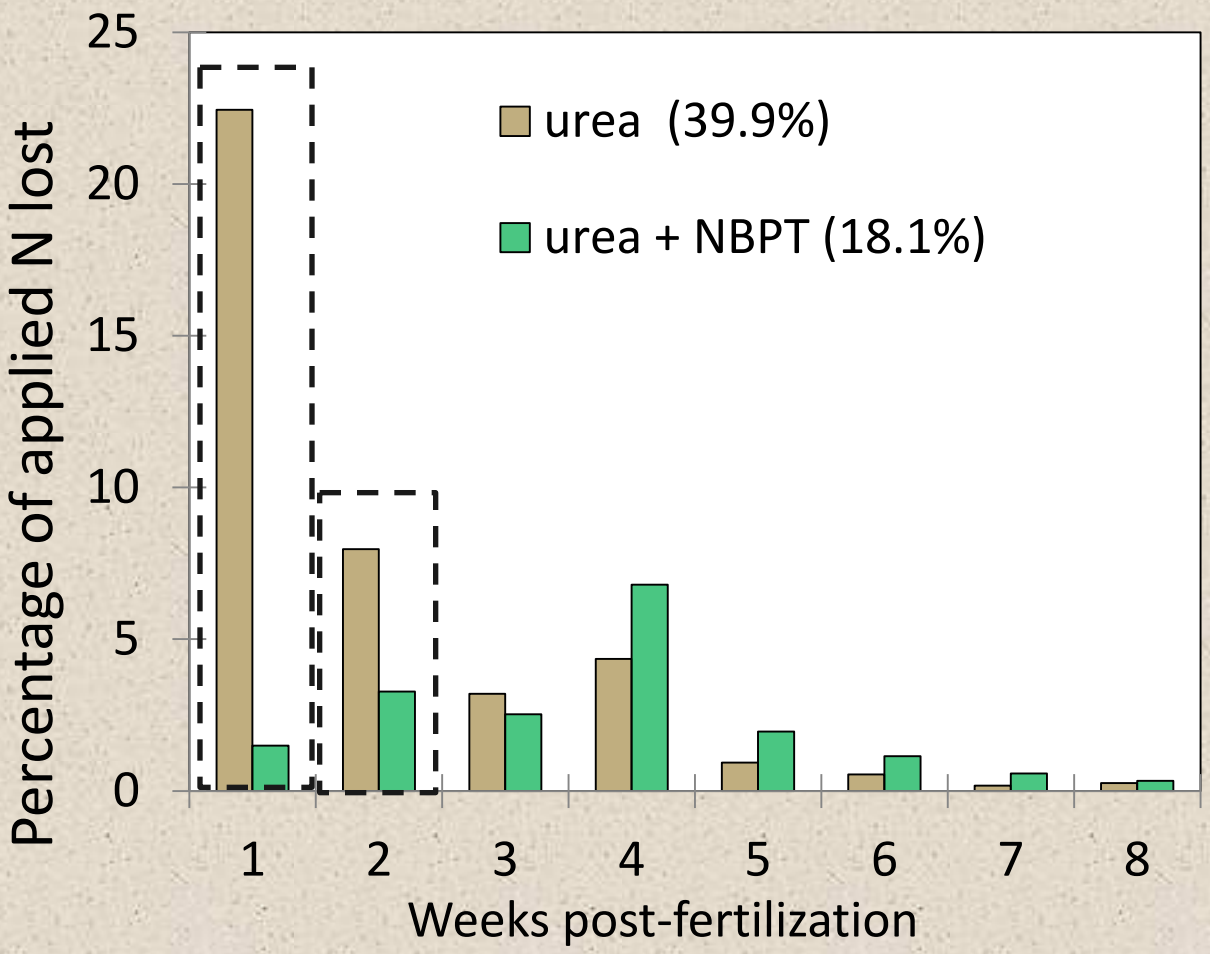
Campaign #5 - high NH_3 losses observed



Fertilizer applied on Mar 26, 2009
light snow on soil surface and air
temp = 21 F

soil surface with fertilizer prills
beginning to dissolve

Campaign #5 - Kaercher farm



Precipitation

no rain 0-2 wks

1.54" 2-8 wks

Mean temperature

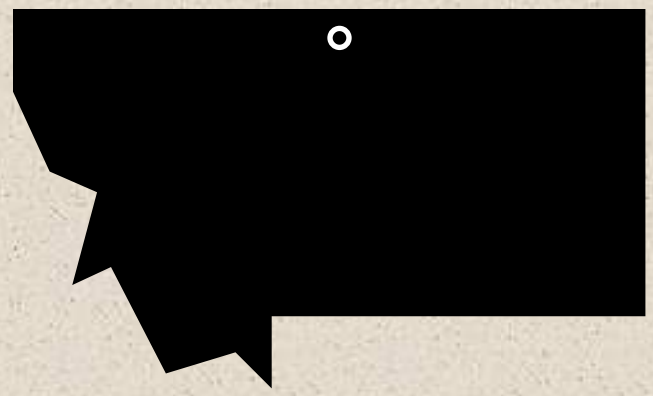
Soil = 38 °F

Air = 39 °F

Conclusion: High losses observed even though temperatures were cold!

Peterson farm site - background

- 28 miles NW of Havre
- Telstad-Joplin loam
- pH 5.5
- no till winter wheat
- Campaigns 3, 4, and 8

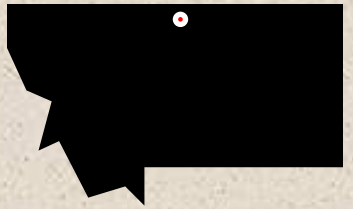


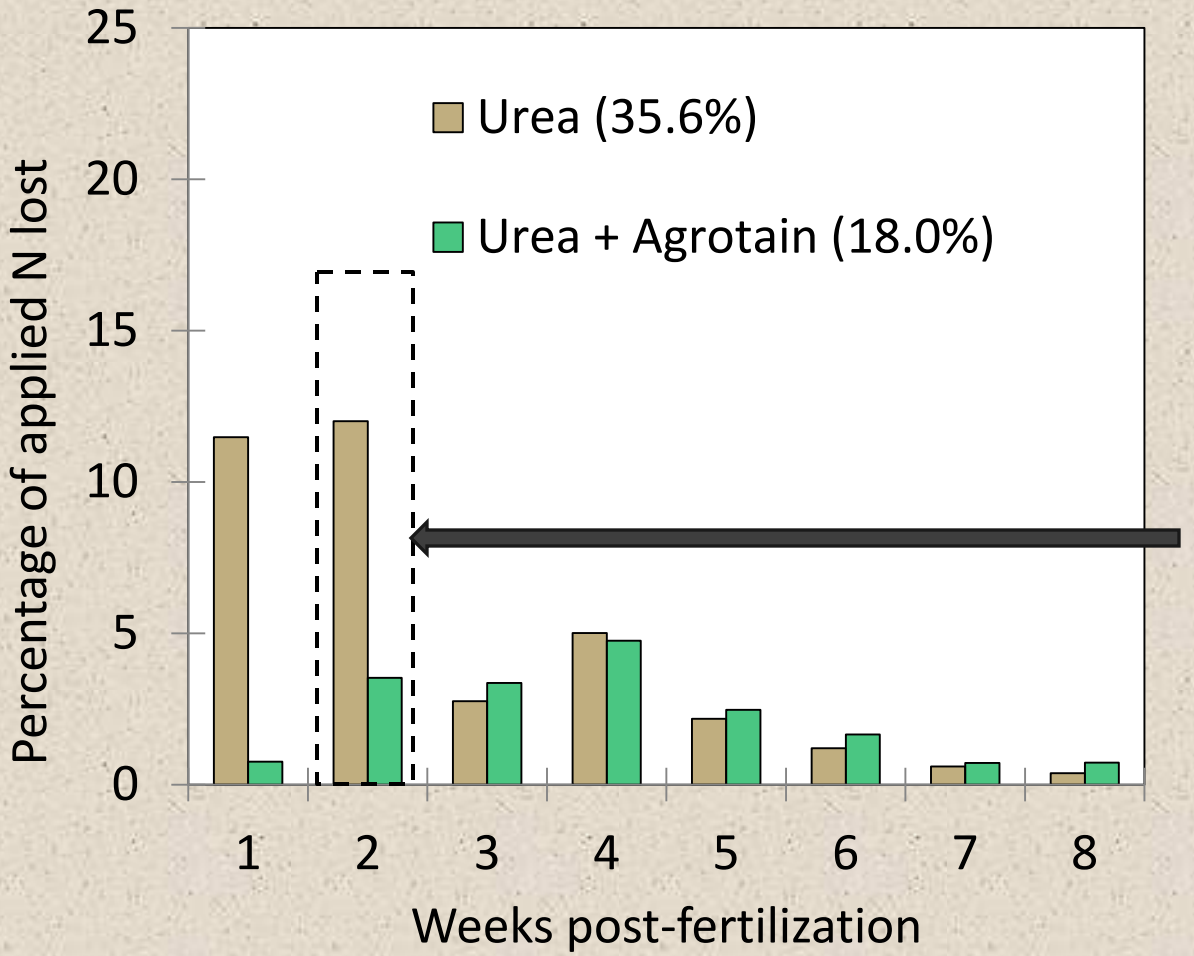
Campaign #4 – Peterson farm

Fertilized applied – March 25, 2009
“light snow & air-temp. 18 °F”

soil surface frozen, 30 °F

Campaign #4 –Peterson farm





Precipitation

0.01” = 0-2 wks

0.89” = 2-8 wks

Soil temp = 30 F

Air temp. = 18 F

Campaign Summary (% N loss)

Campaign	Fertilization date	Urea	NBPT-urea
1	April 3, 2008	8.4	4.4
2	Oct 8, 2008	3.1	1.4
3	Nov 14, 2008	31.5	4.0
4	March 25, 2009	35.6	18.0
5	March 26, 2009	39.9	18.1
6	Oct 6, 2009	10.7	3.3
7	Oct 13, 2009	10.4	4.8
8	Oct 19, 2009	15.7	3.4
9	Jan 27, 2010	24.3	9.3
10	Feb 26, 2010	44.1	11.9
11	March 29, 2010	6.3	1.7
12	April 20, 2010	14.7	1.4
Average		**20.4**	**6.8**

wide range in N loss amounts

http://landresources.montana.edu/ureavolatilization

Summary – take home messages

- Significant ammonia losses (30-40% of applied N) from surface-applied urea can occur even though soil temperatures are near freezing!
- Soil moisture conditions at surface that dissolve urea granules (i.e. prolonged damp) without rain promote high ammonia losses (*more common to find these conditions in MT during late fall or early spring*)
- NBPT (Agrotain) reduced losses 62% over untreated urea

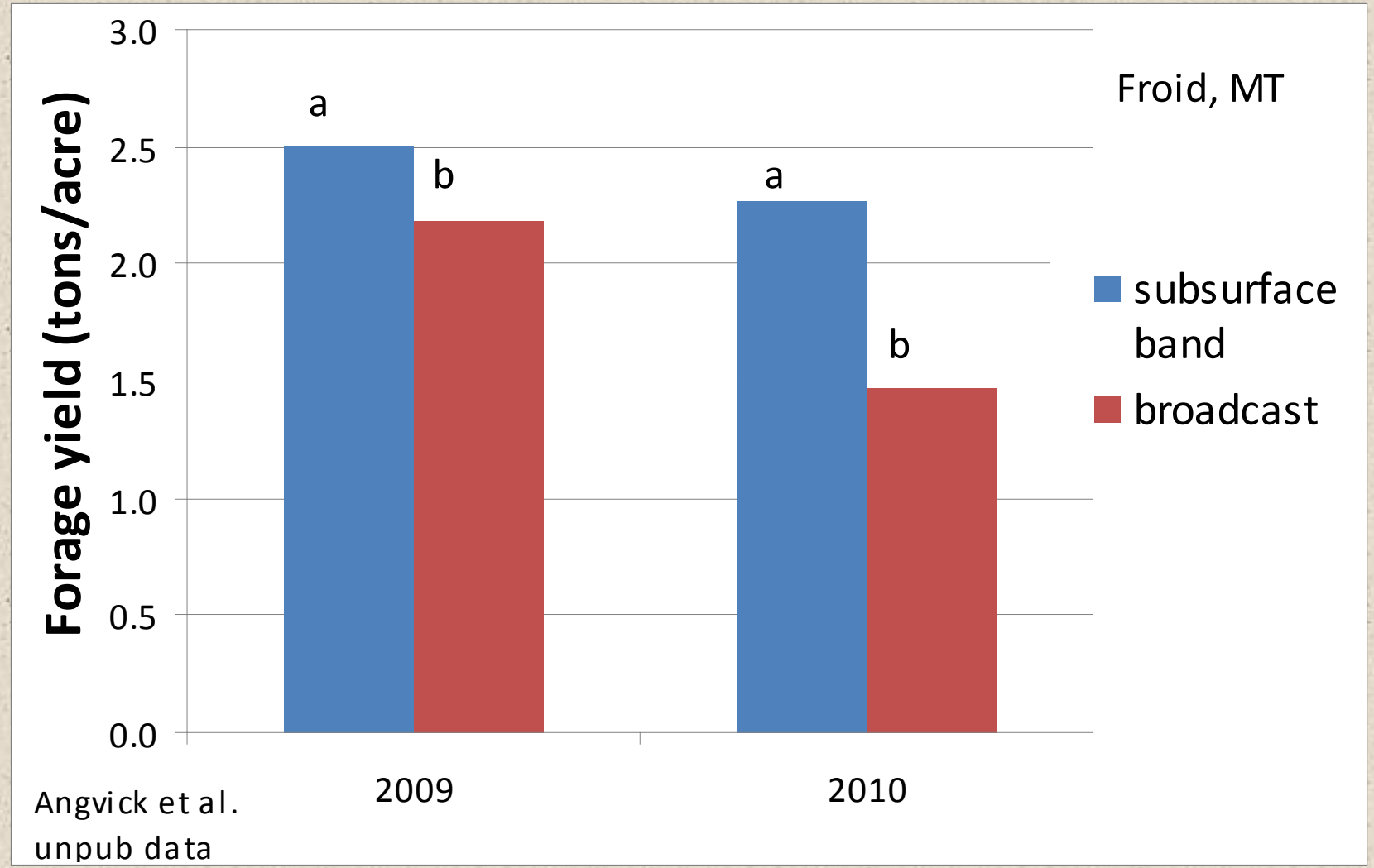
Support

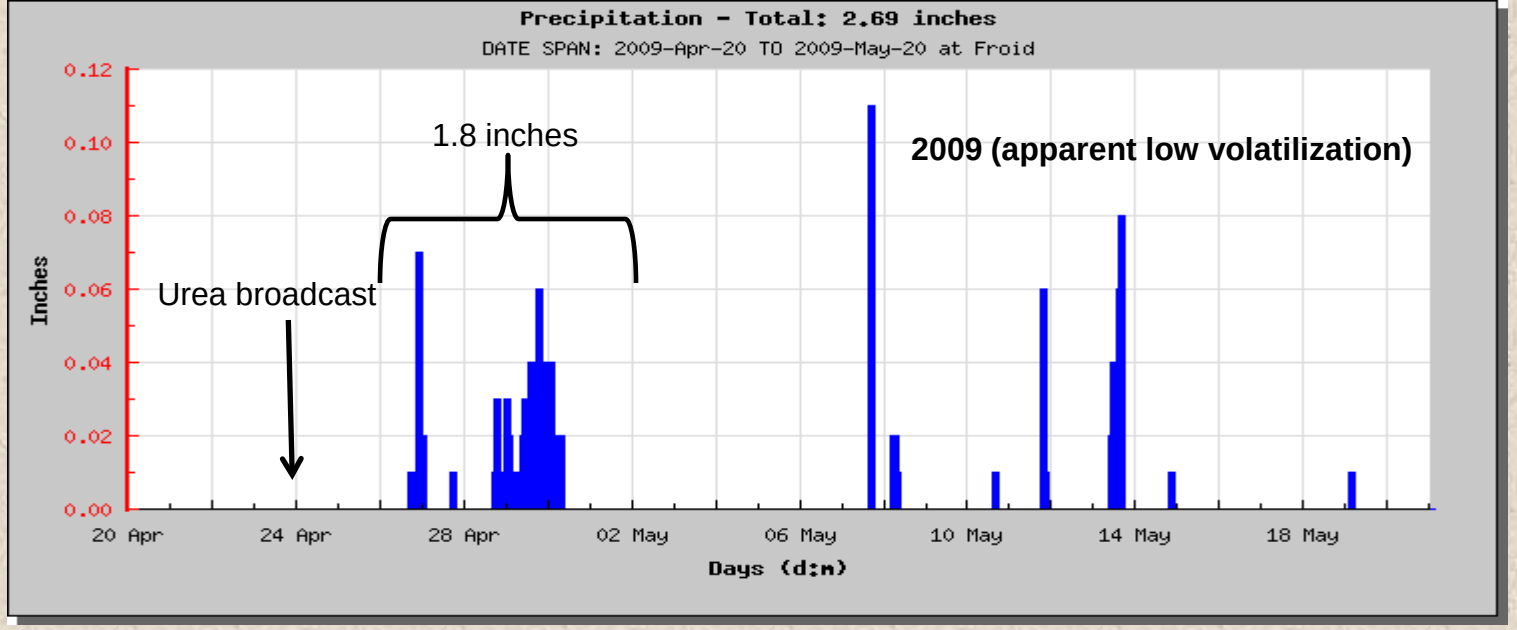
- WSARE
- MT Fertilizer Advisory Committee
- MT Wheat and Barley Committee
- NRCS-CIG program
- International Plant Nutrition Institute
- Agrotain International

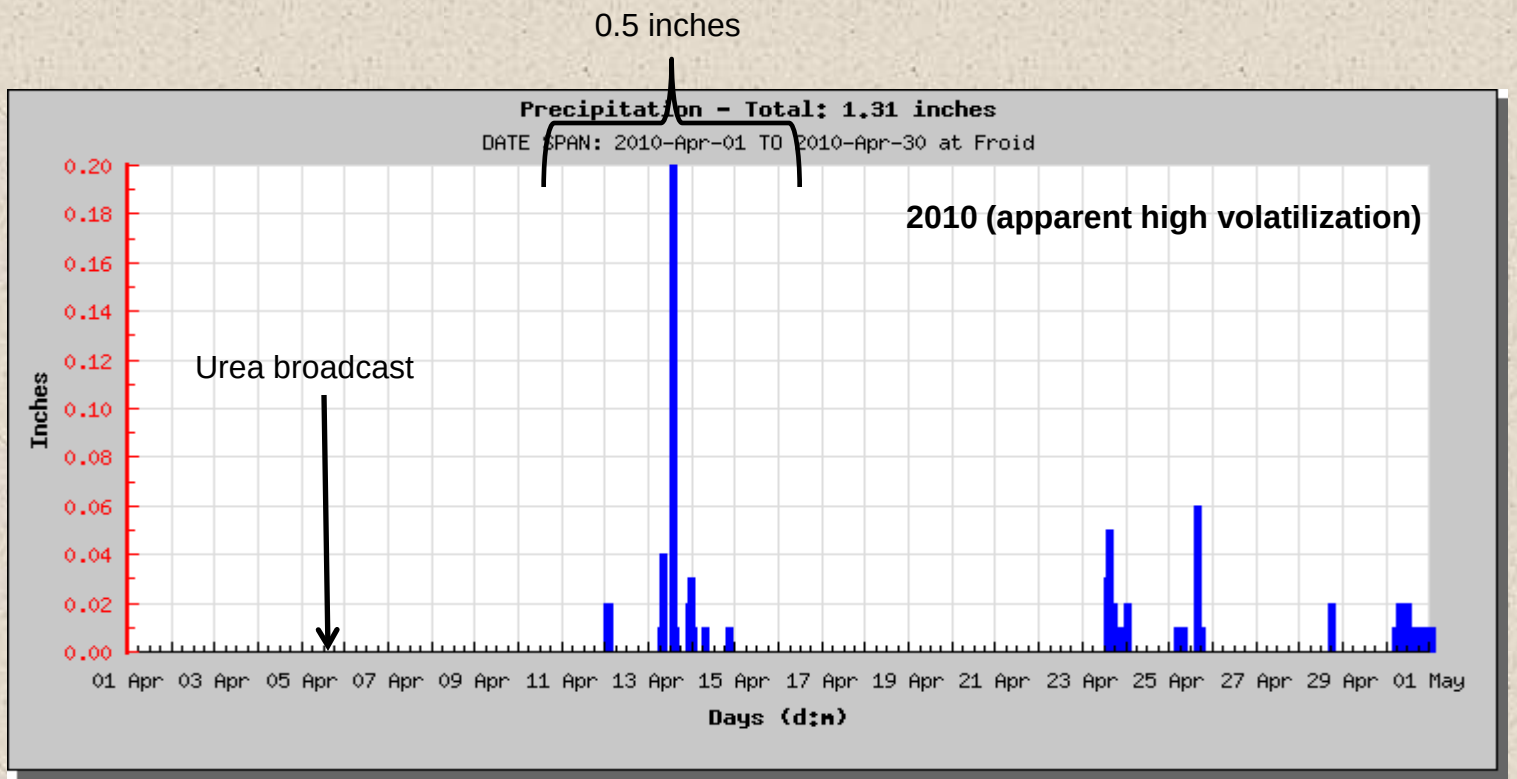
If ~20% of broadcast urea is lost, why didn't MT research from the 1990s show large yield/protein losses compared to ammonium nitrate and/or subsurface banding? (Jones et al. 2007)

1. Adequate precipitation may have occurred after application.
2. Urea takes 2 - 5 weeks to become available whereas AN is immediately available for plants and for other losses-urea's 'slow release' property may increase its efficiency, making up for loss.
3. About 50% of N uptake comes from fertilizer (rest from soil). So 20% of 50% is 10% difference in N availability-might not make a statistically SIGNIFICANT difference (though still a bottom line difference).
4. With longer term no-till could 'urease' enzyme concentrations have increased? It is known that residue contains more urease than soil.
5. With longer term no-till, some calcium has likely leached out of surface soil. Calcium is known to decrease volatilization and most source studies were conducted last decade.

Effect of Urea Placement on Hays Barley (Annual Forage) Yield



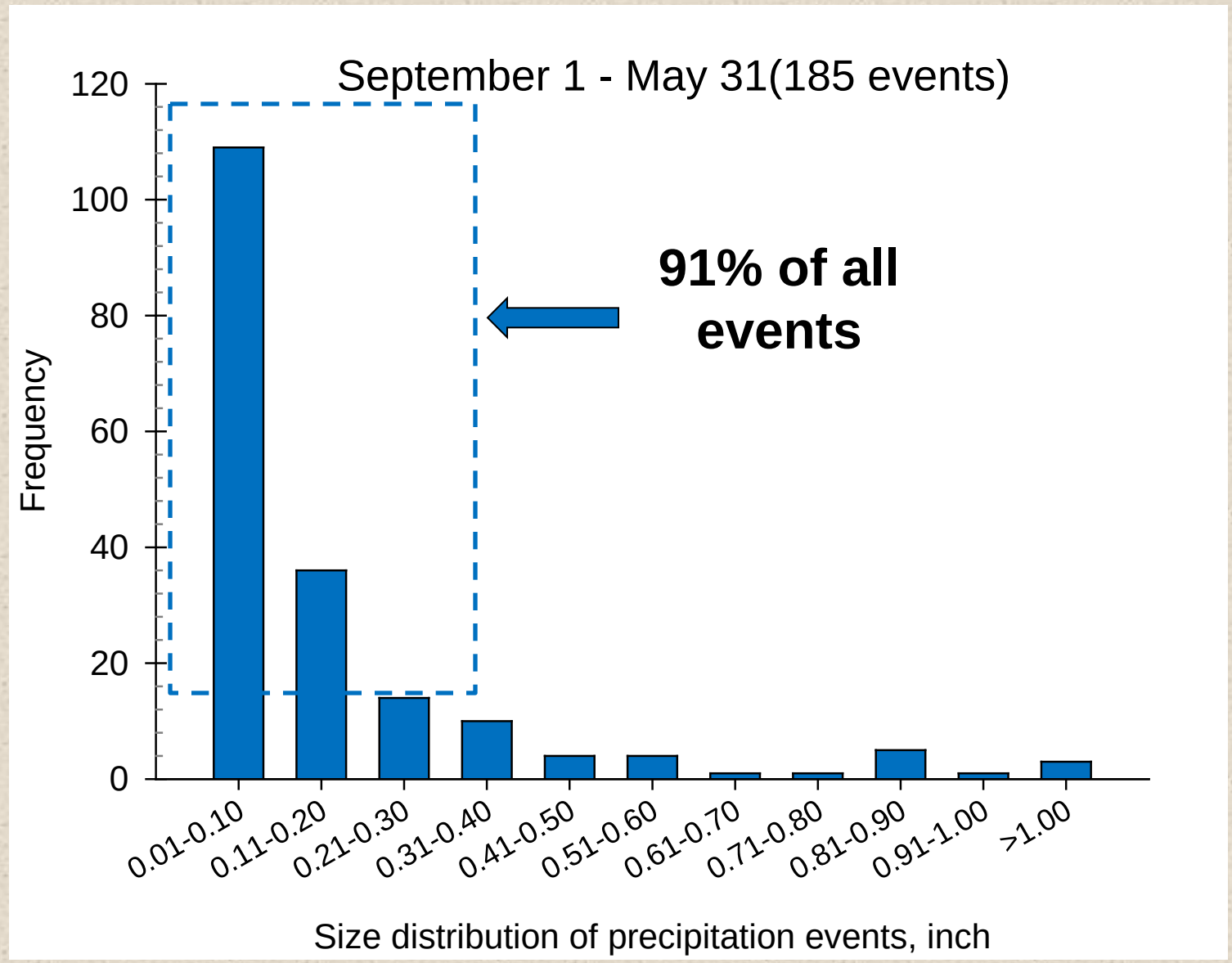

Precipitation - Total: 2.69 inches
DATE SPAN: 2009-Apr-20 TO 2009-May-20 at Froid
1.8 inches
2009 (apparent low volatilization)
Urea broadcast
Inches
0.12
0.10
0.08
0.06
0.04
0.02
0.00
20 Apr
24 Apr
28 Apr
02 May
06 May
10 May
14 May
18 May
Days (d:m)


0.5 inches
Precipitation - Total: 1.31 inches
DATE SPAN: 2010-Apr-01 TO 2010-Apr-30 at Froid
2010 (apparent high volatilization)
Urea broadcast
Inches
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
01 Apr
03 Apr
05 Apr
07 Apr
09 Apr
11 Apr
13 Apr
15 Apr
17 Apr
19 Apr
21 Apr
23 Apr
25 Apr
27 Apr
29 Apr
01 May
Days (d:m)

Light ppt events (≤ 0.4”) are common

along the Highline

Size and frequency of precipitation events Havre Airport (last 5 years)



What should you do to minimize volatilization?

1. Do not apply urea on moist ground UNLESS a snow or rainstorm is forecast to drop at least ½ inch of rain in a day. Preferably more (unlikely unfortunately!).
2. If you irrigate, apply ½ inch of irrigation after urea application.
3. Apply urea below the surface – either in a midrow band, 2 inches from the seed or with the seed with a ‘protected’ product or a wide opener.
4. Consider seeding right after urea application to cover some urea; wider openers will help with this. (We’re currently testing effectiveness of this practice)
5. Consider using Agrotain or ammonium nitrate (if available) if can’t apply during a low risk time.

Other Resources

- Soil Fertility information: http://landresources.montana.edu/soilfertility
- Above link contains an Economic N rate calculator, Fertilizer Fact sheets, Press Releases, and Extension documents like Nutrient Uptake Timing by Crops and Enhanced Efficiency Fertilizers
- Link also will contain this presentation in a couple days

Questions?