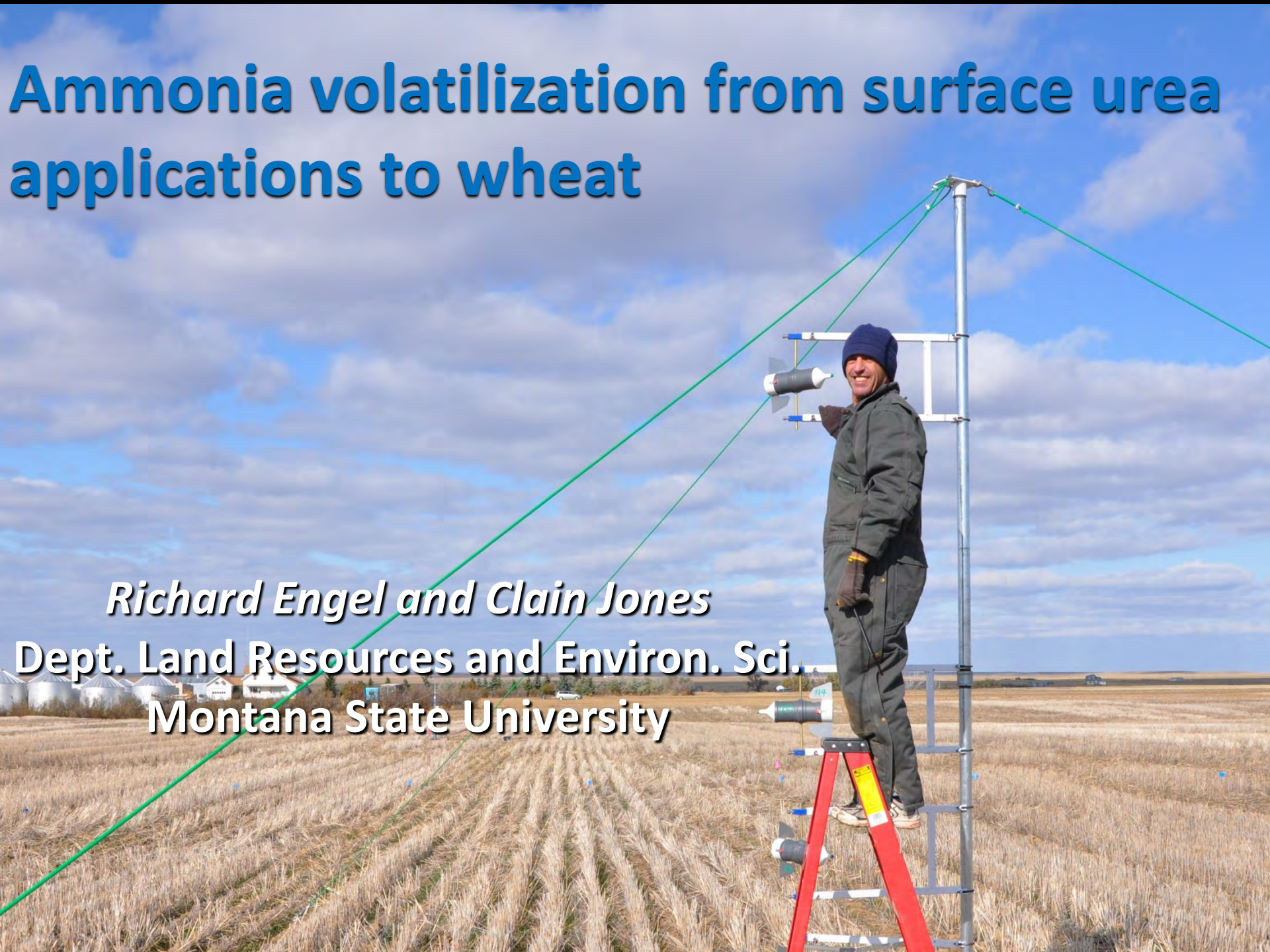
Ammonia volatilization from surface urea applications to wheat



Richard Engel and Clain Jones
Dept. Land Resources and Environ. Sci.
Montana State University


surface urea applications are susceptible to volatilization losses


double-shooting urea
- best mitigation technique -

Winter wheat production in Montana

- no till has become norm
- volatilization risks are often greater no till
- N fertilizer applications deferred to until fall, winter, and early spring (cold weather months) – to expedite seeding operations
- <u>How much N are we losing?</u>

Goals

- **How much N as NH_3 are we losing from surface-applied urea (fall, winter, and early spring)?**

Does this represent a large economic loss? If so, what are the conditions where the largest N losses are observed ?

Do cold temperatures provide protection against volatility losses?

Goals

- **Defining mitigation strategies to minimize NH_3 loss ?**

  - *Timing*
  - *Enhanced efficiency N products (NBPT or Agrotain) ?*
  - *Incorporation & subsurface urea applications*
  - *alternate N sources – UAN, ESN*

Methods-Integrated horizontal flux

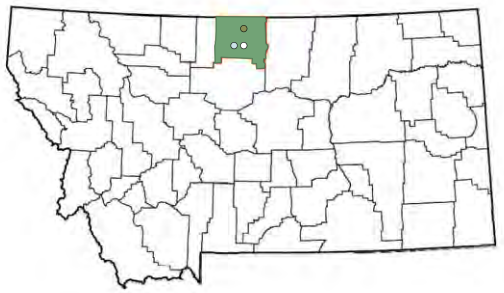
- micrometeorological - mass balance
- does not disturb the soil-atmosphere environment
- continuous measurement of gas loss over time

mast and shuttles

Methods – On farm studies

High NH_3 loss campaigns (>30%)

Campaign	Fertilization date	% urea-N volatilized
3 - north Havre	Nov. 14, 2008	31.5
4 - north Havre	March 25, 2009	35.6
5- west Havre	March 26, 2009	39.9

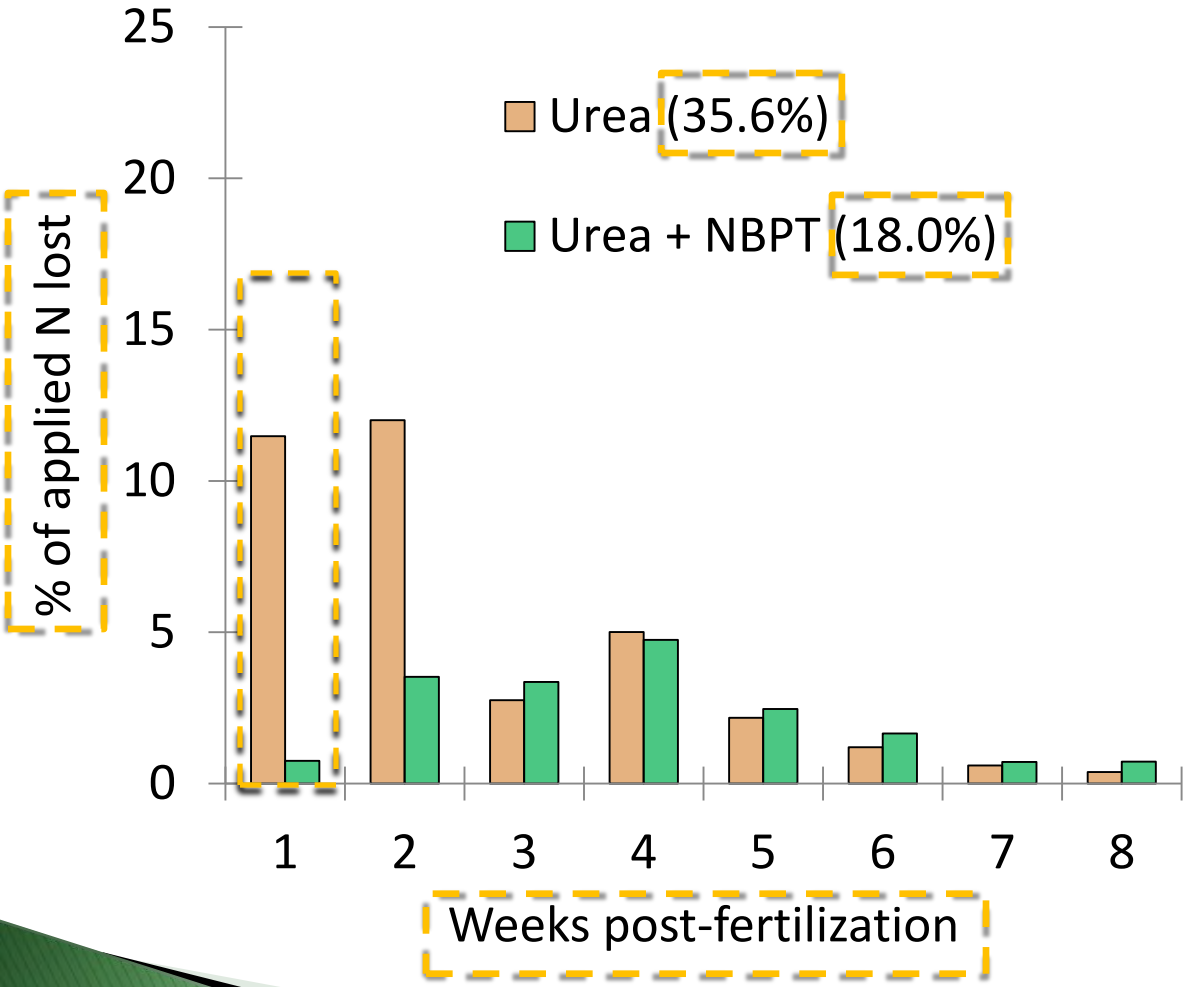


High NH_3 losses – Campaign 4 (TJ loam)

Fertilized applied – March 25, 2009
"light snow & air-temp. 31°F"

soil surface frozen 18 °F
Θ_v = 35%

High NH_3 losses – Campaign 4 (TJ loam)



Precipitation

0.01” = 0-2 wks

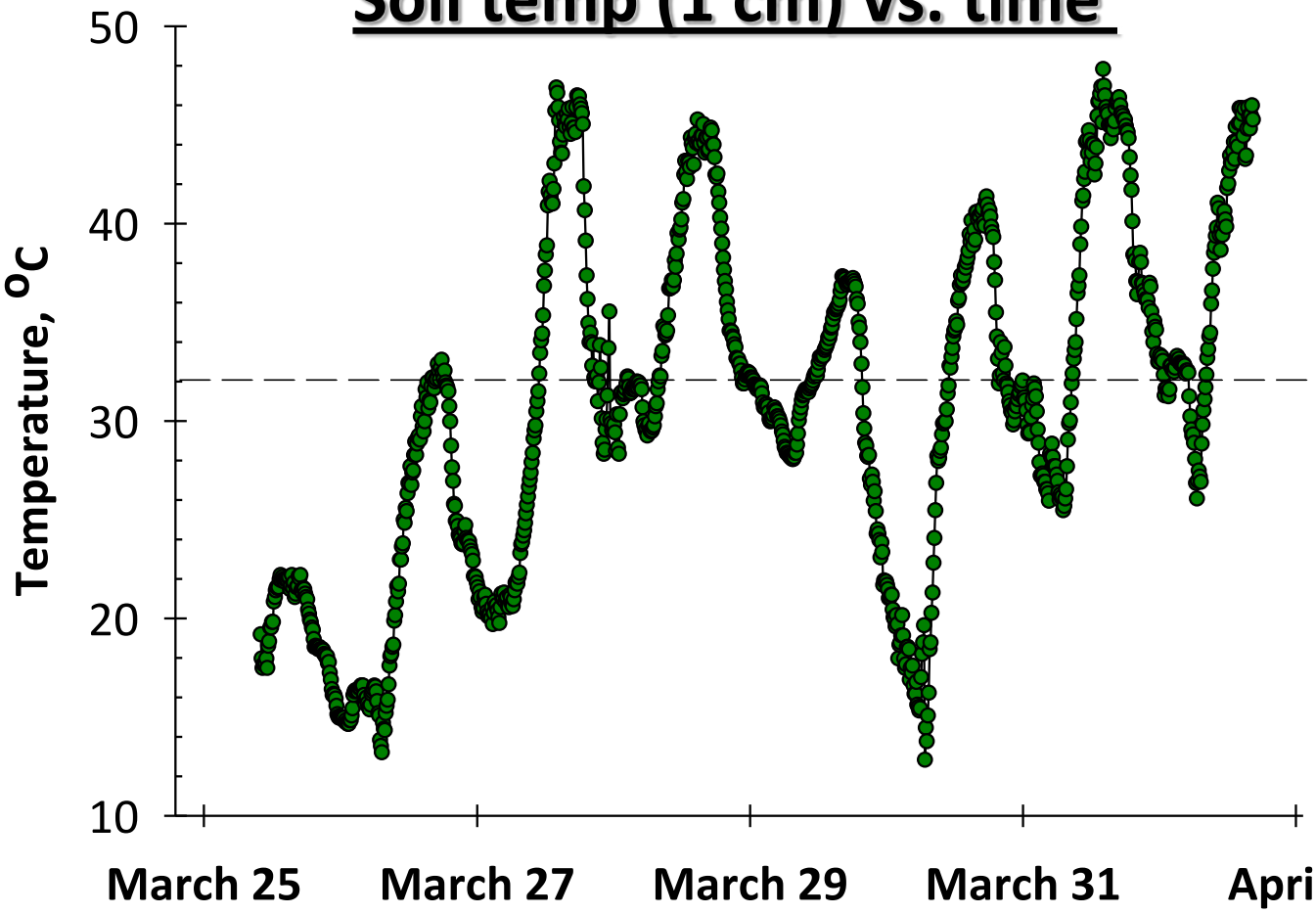
0.89” = 2-8 wks

Temperature

Soil = 30.7 °F

Air = 33.4 °F

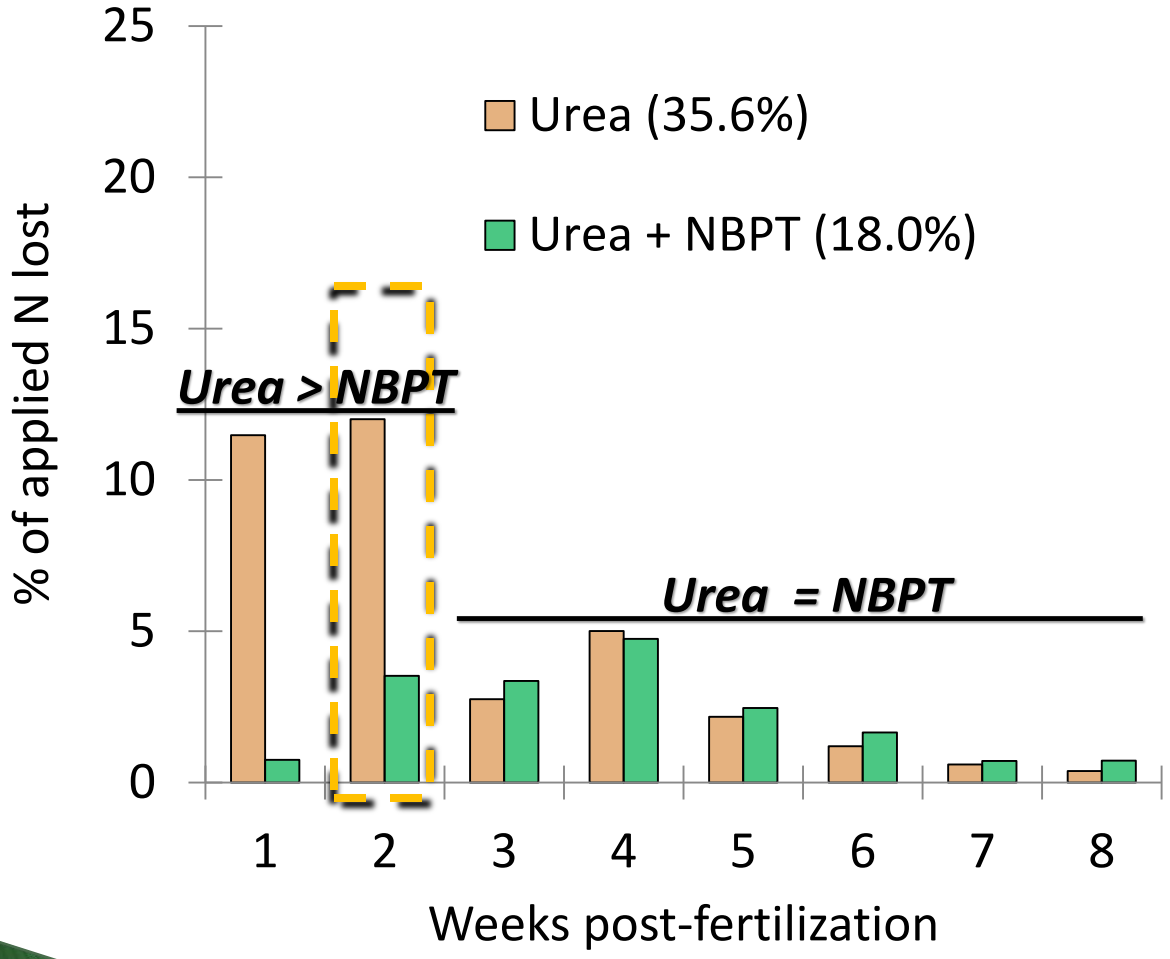
High NH_3 losses – Campaign 4 (TJ loam)



diurnal variation

mean = 30.7°F

High NH_3 losses – Campaign 4 (TJ loam)



Precipitation

0.25” = 0-2 wks

0.89” = 2-8 wks

Temperature

Soil = 38.0 °F

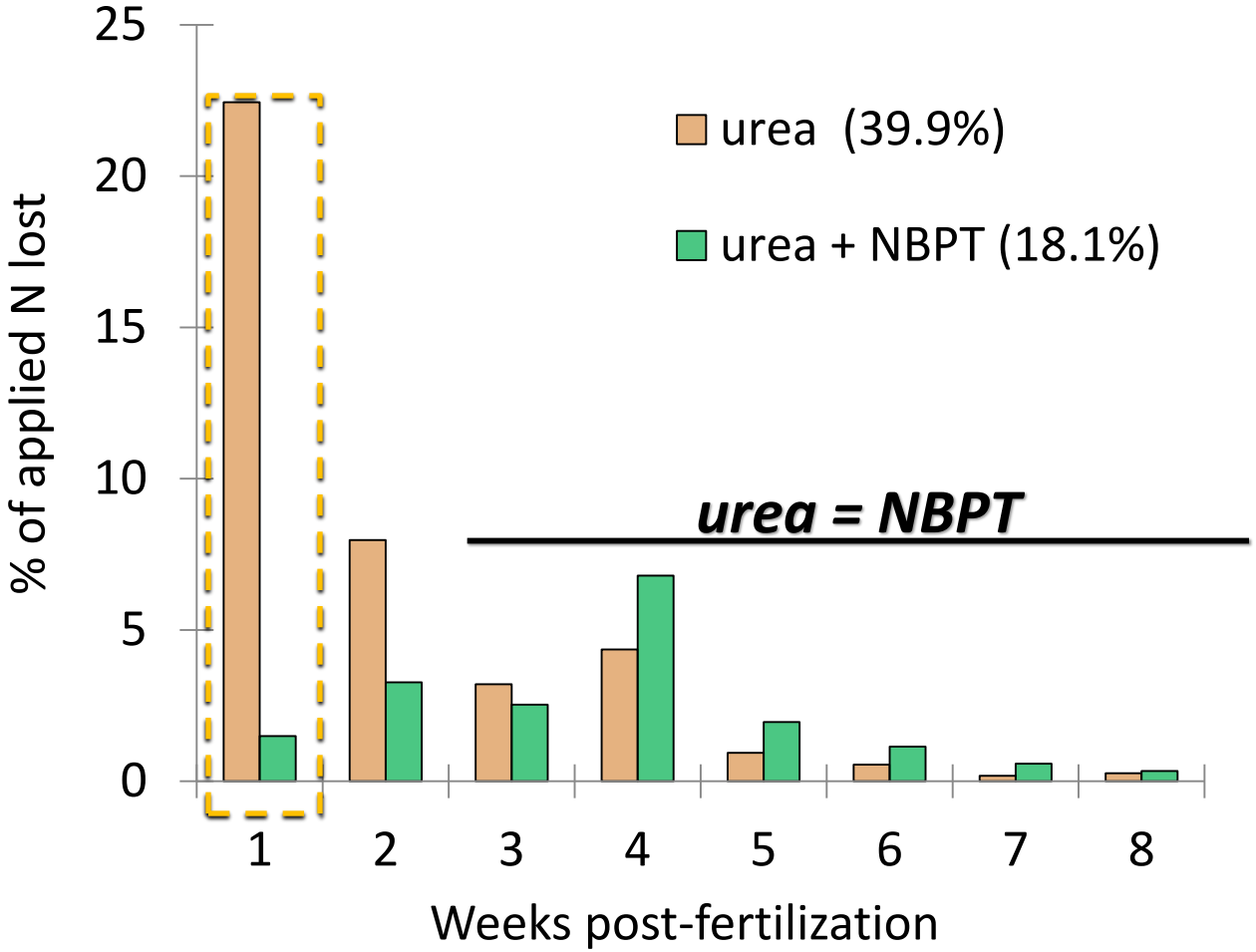
Air = 41.5 °F

High NH_3 losses - Campaign 5(PE silt loam)

Fertilized applied – March 26
"light snow on soil surface &
air-temp. 21 °F"

soil surface with fertilizer
prills beginning to dissolve
32 °F

High NH_3 losses - Campaign 5(PE silt loam)



Precipitation

no rain 0-2 wks

1.54" 2-8 wks

Temperature

Soil = 34.3 °F

Air = 33.1 °F

High NH_3 losses – Campaign 3 (TJ loam)

Surface damp from melting 2” snowfall event
November 14, 2008

High NH_3 losses from urea -what to avoid -

- Do not apply urea to damp or wet soil surfaces. Wet + slow drying is ideal for seeing large NH_3 losses.
- Example – early spring or late winter; ground may be wet; soil frozen at night, but thaws during the day

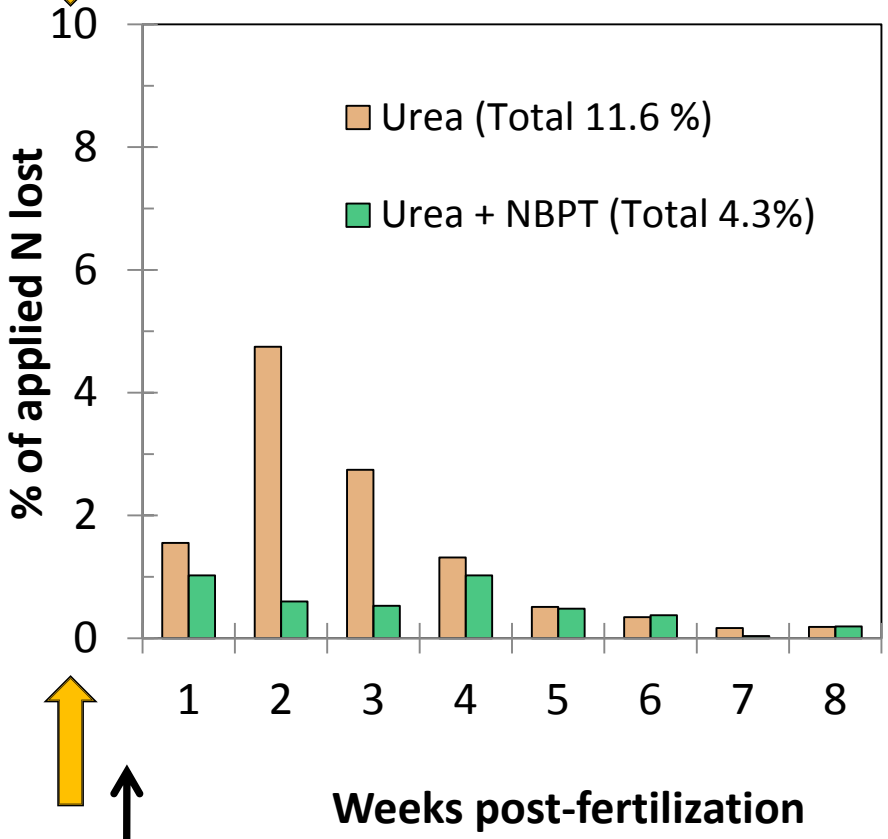
Moderate NH_3 loss campaigns (10-20%)

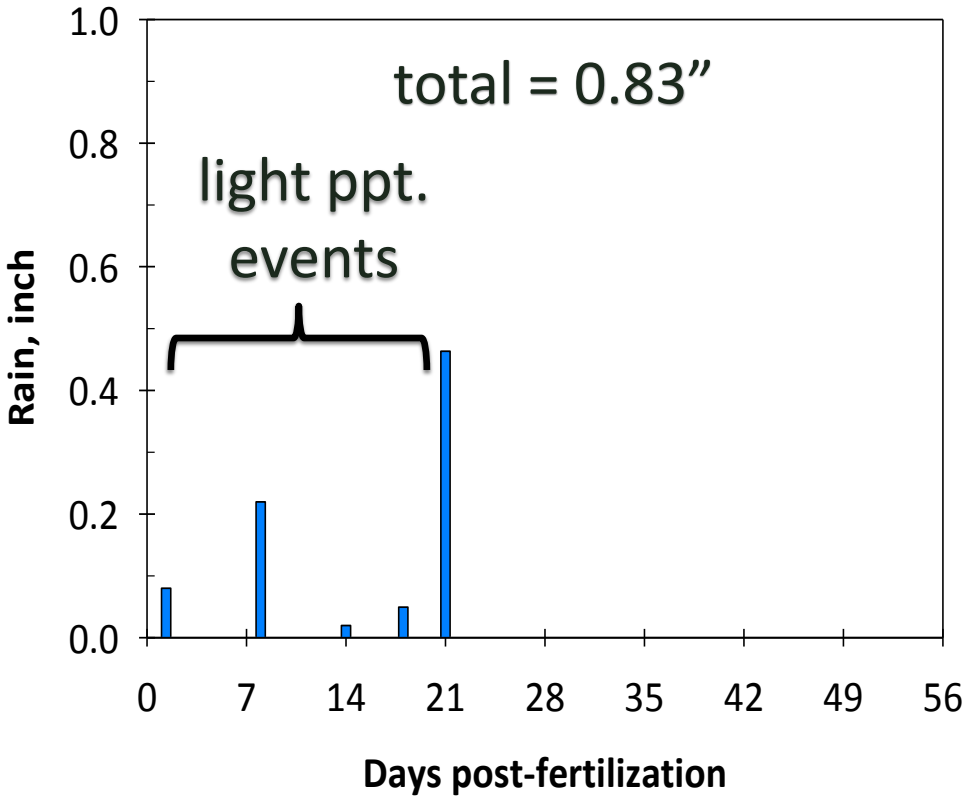
- **urea applied to dry soil surface**

Campaign 6
Oct. 6, 2009

Campaign 7
Oct. 13, 2009

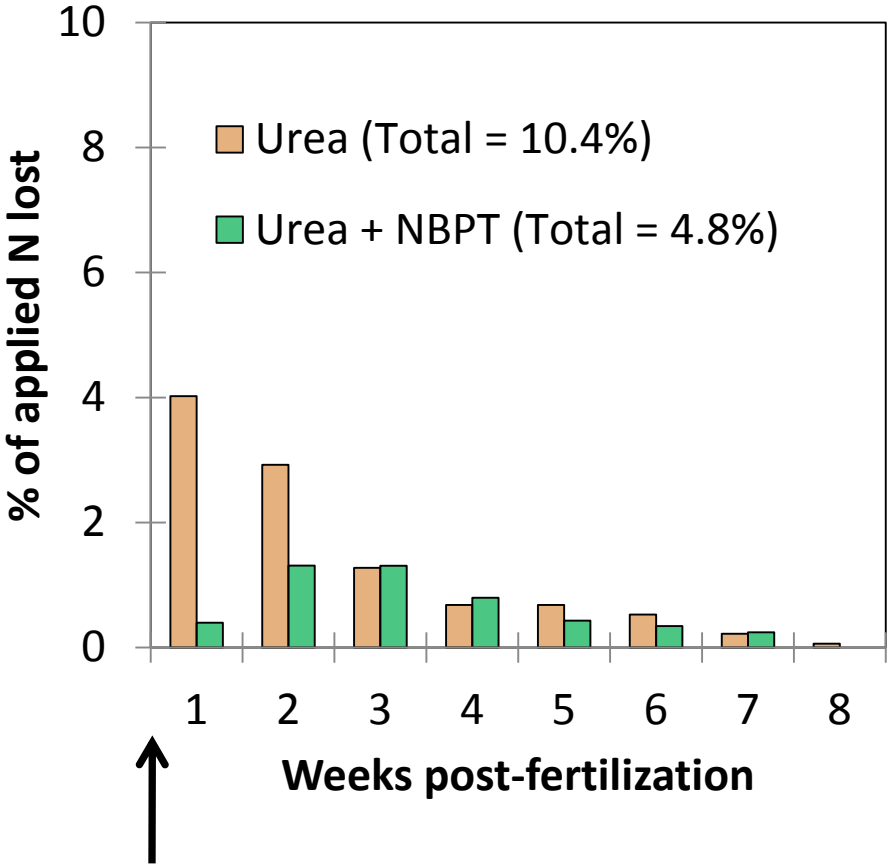
Moderate NH_3 loss - Campaign 6 (clay loam)



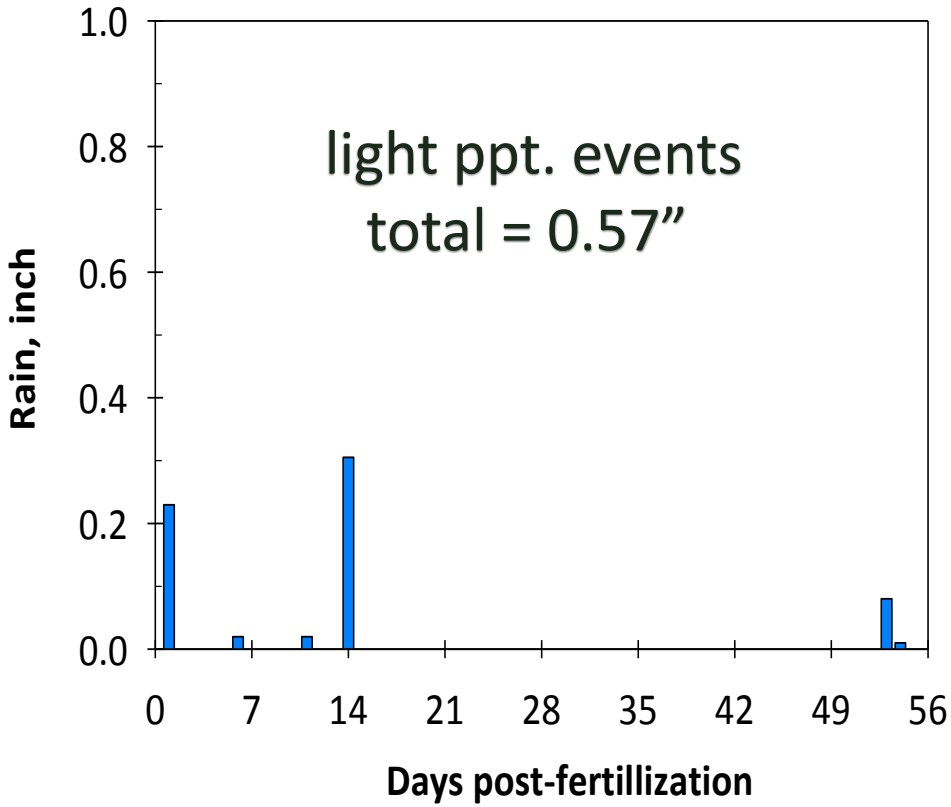


October 6

Moderate NH_3 loss – Campaign 7 (PE silt loam)



October 13



Montana's semiarid environment

"splash and dash ppt events"

What is meant by a precipitation event ?

Day	November 2010	
12	.	
13	.	
14	0.02	
15	0.01	*0.32”*
16	0.29	
17	.	
18	0.04	
19	.	
20	0.22	
21	0.02	
22	0.16	
23	0.19	*0.63”*
24	0.01	
25	0.03	
26	.	
27	.	

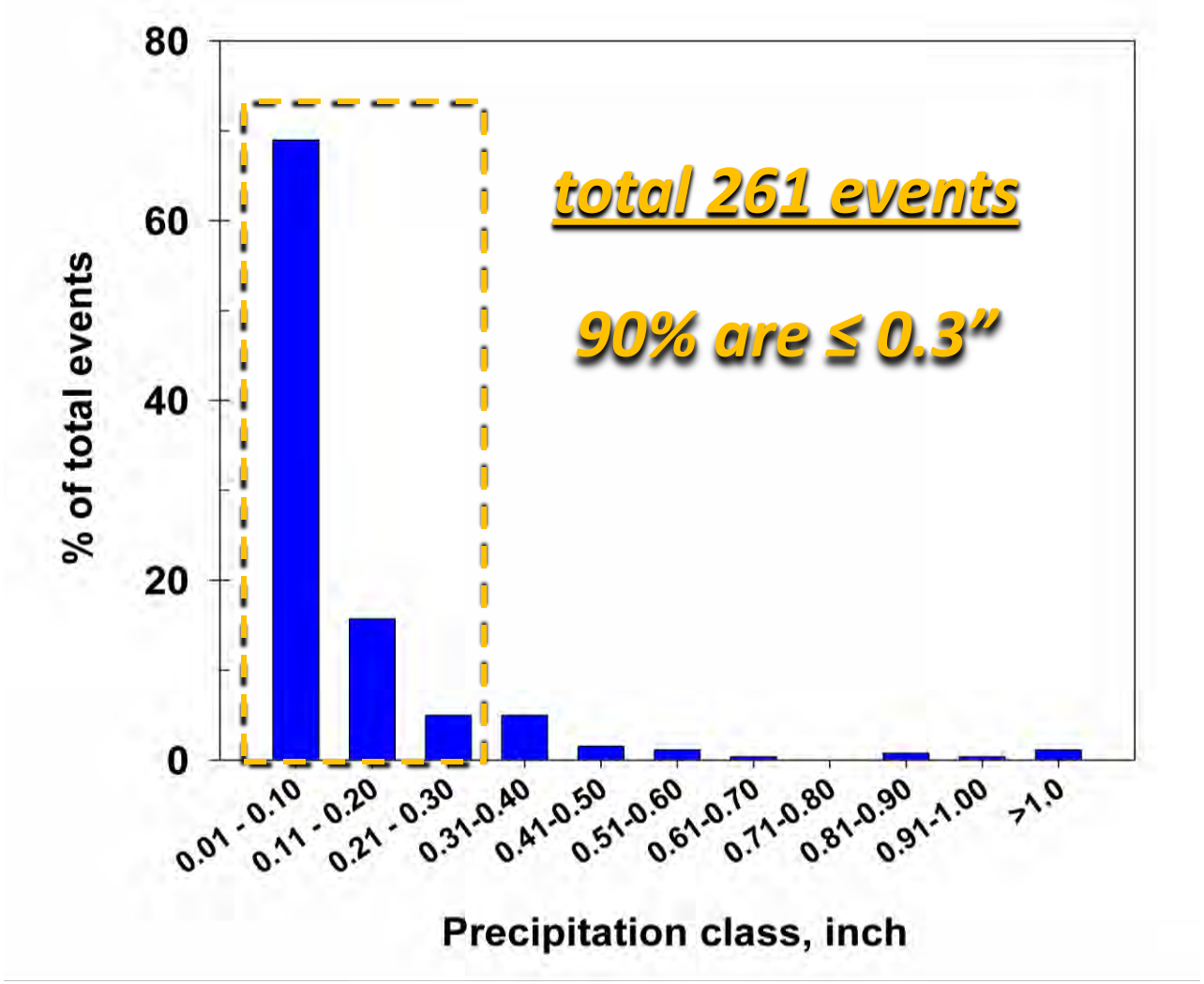
= continuous days with measureable ppt.

Size and frequency of precipitation events between Oct – April (last 10 years)

Havre Airport

7 month ppt. ave. 3.1”

~50% falls as ≤ 0.3” events

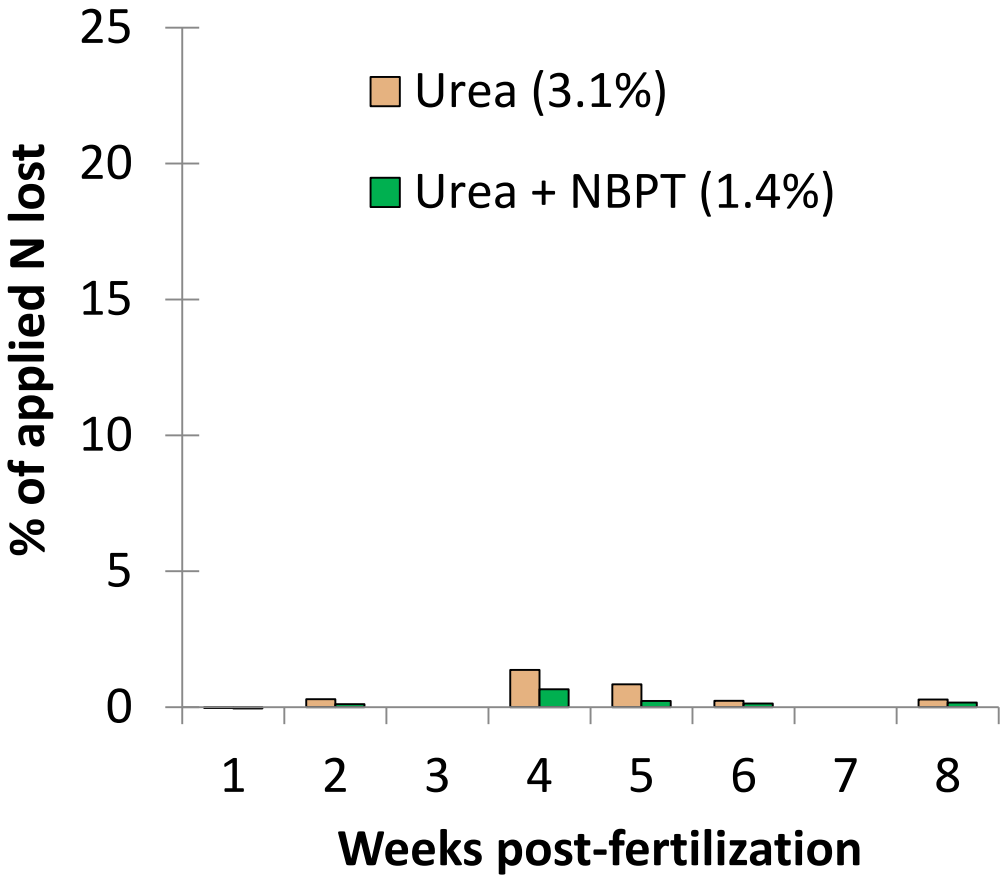


Campaign 2 – low NH_3 losses (<10%)

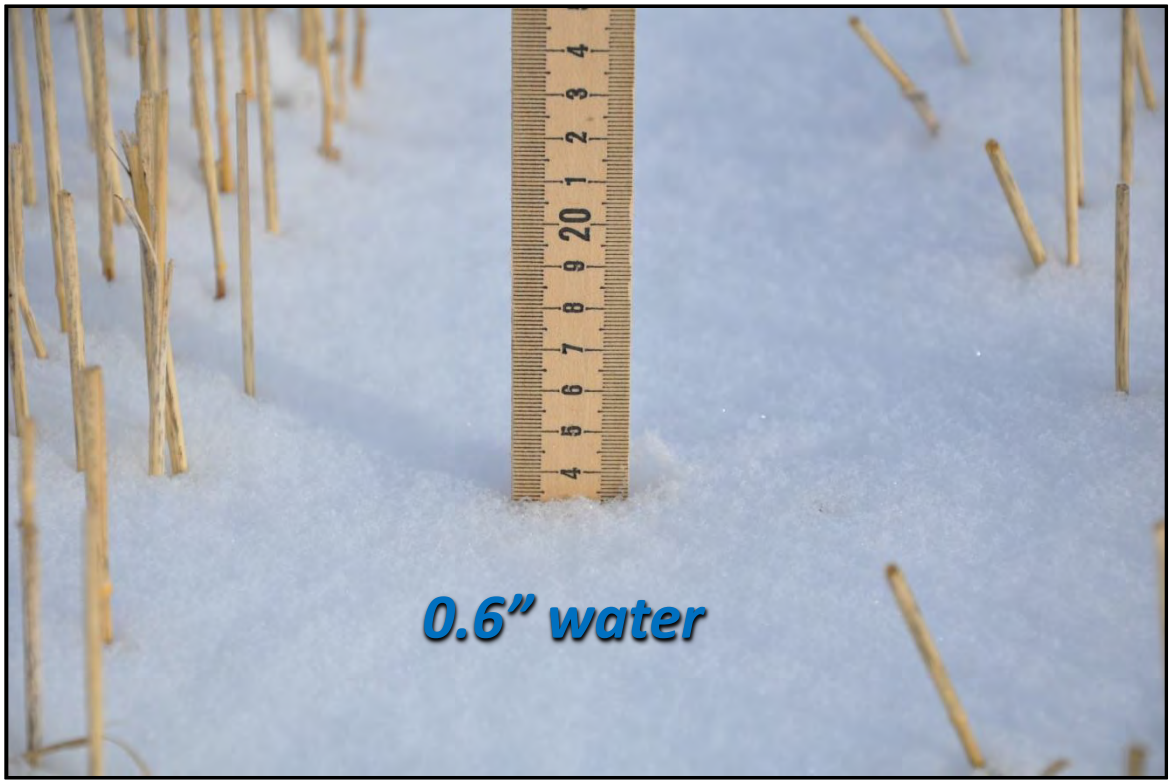
- October 9, 2008 application, air-temp. 45 °F, dry soil surface
- no rain for 24 days & then Nov 2-5 received 1.0" ppt.
- same field site as Campaign 5

1 wk post-fertilization
prills not dissolved

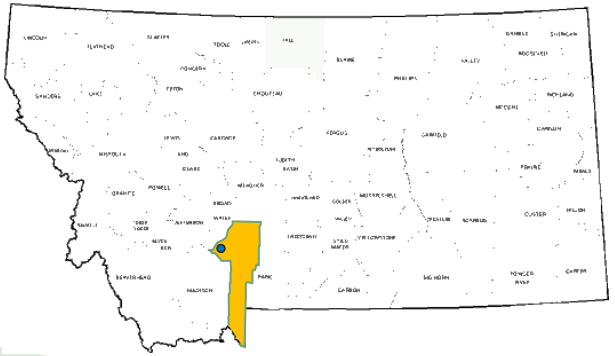
Campaign 2 – low NH_3 losses



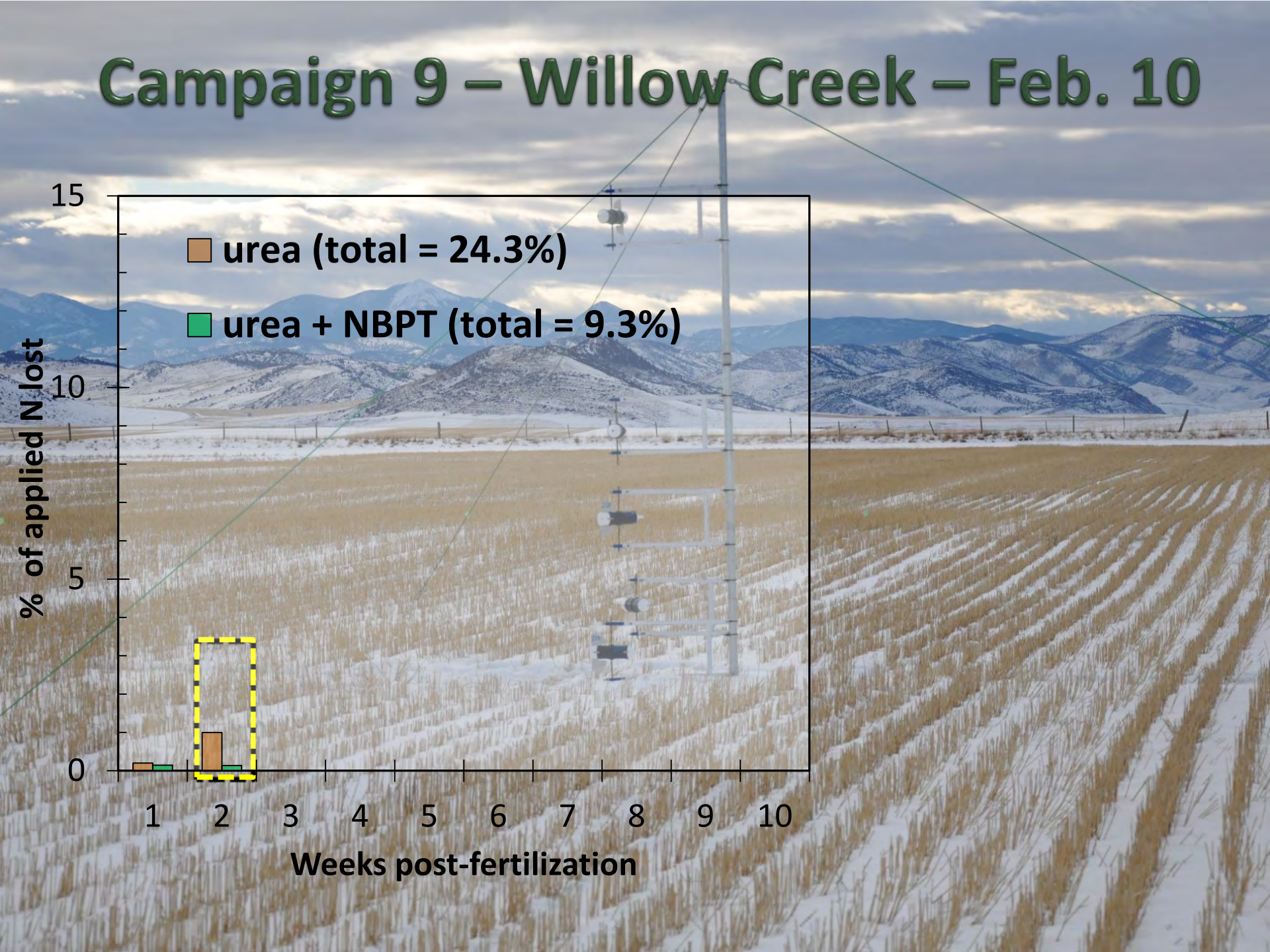
What about urea on snow ?
Campaign 9 - Willow Creek - Jan 27, 2010



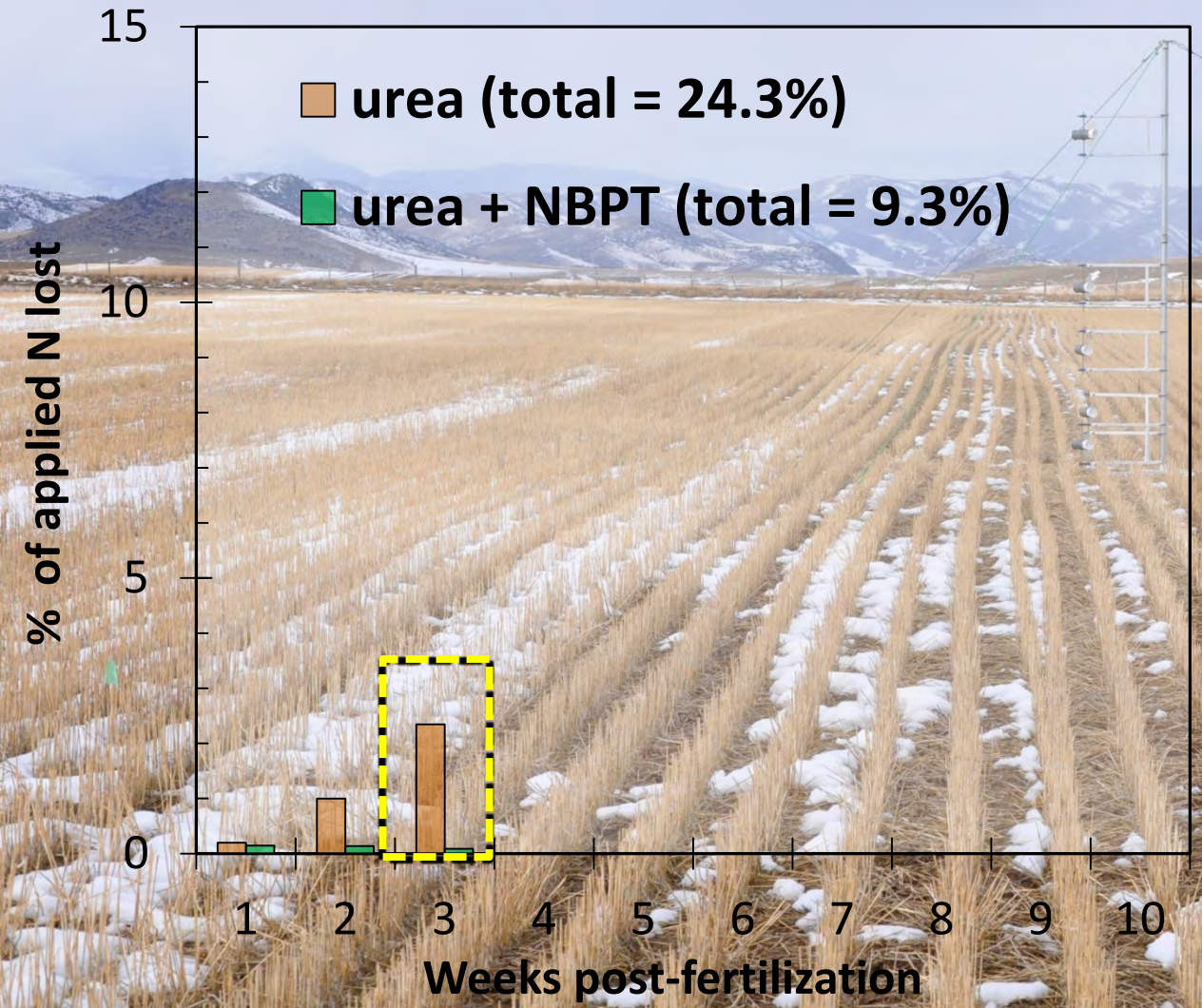
calcareous soil = pH 8.4



Campaign 9 – Willow Creek – Feb. 10

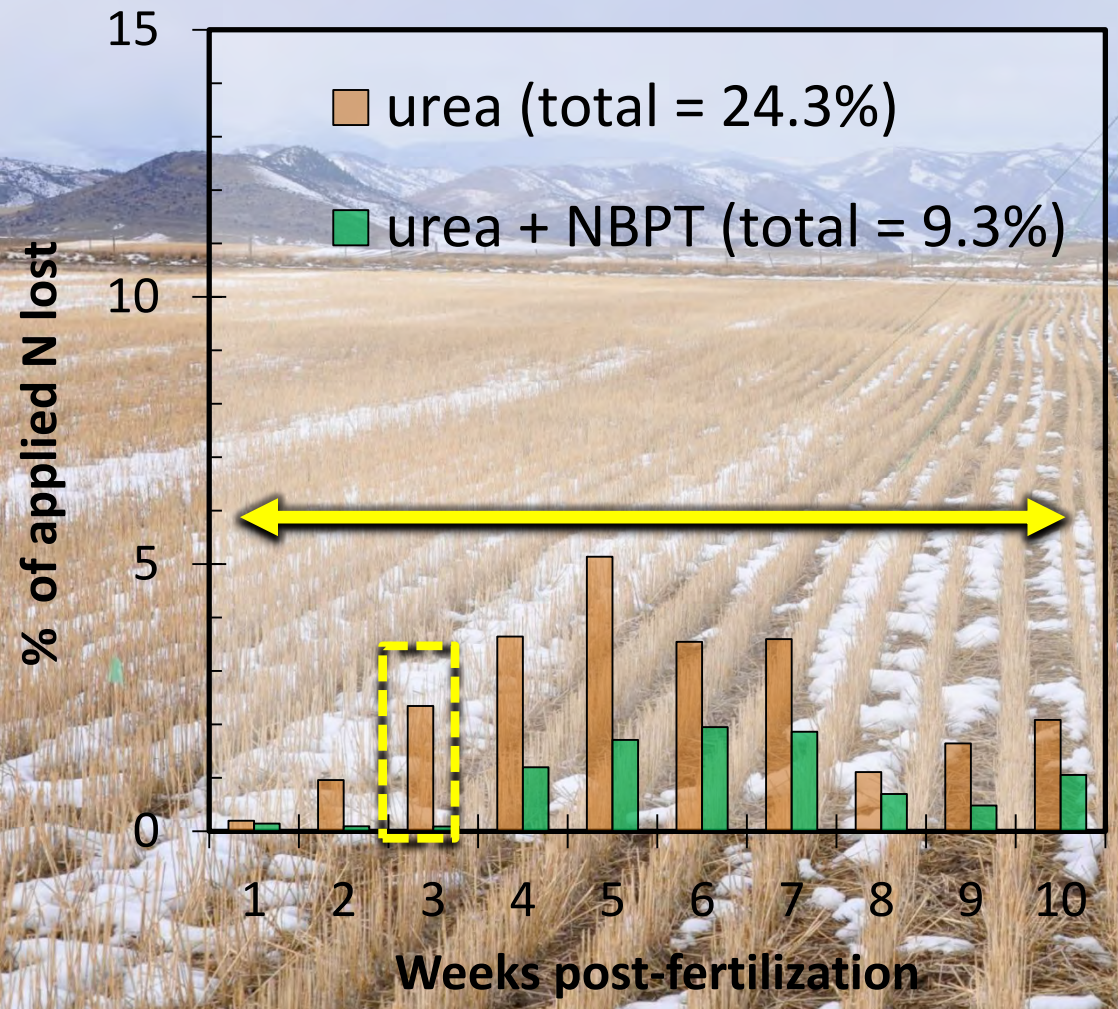


Campaign 9 – Willow Creek – Feb. 17



- no run off

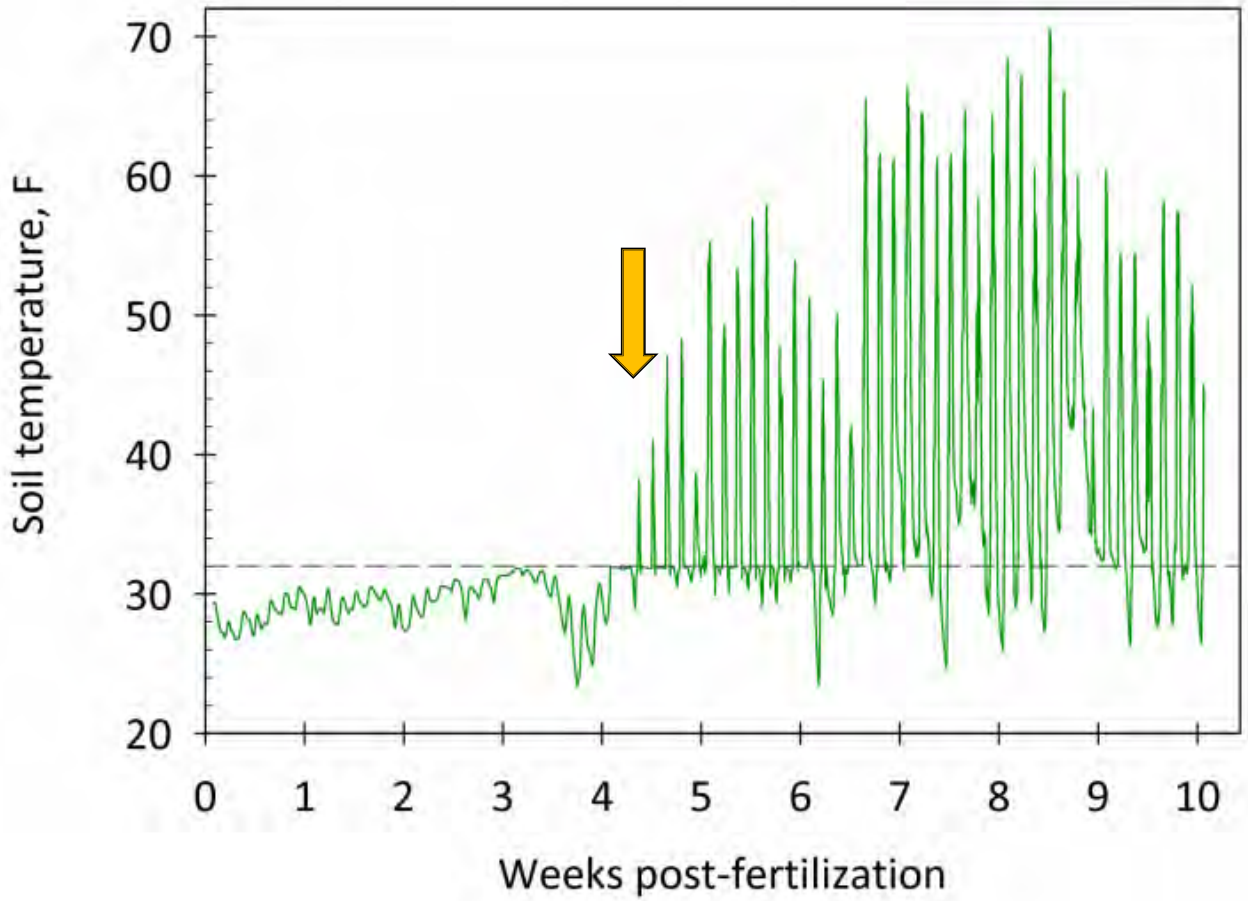
Campaign 9 – Willow Creek – Feb. 17



no run off !

NBPT - prolonged activity

Campaign 9 – Soil temperature (1 cm)



- ***12.3% applied N lost 0-5 wk***
- ***soil temp. 30.0˚F***

Campaign Summary (% N loss)

Campaign	Fertilization date	Urea
1	April 3, 2008	8.4
2	Oct 8, 2008	3.1
3	Nov 14, 2008	31.5
4	March 25, 2009	35.6
5	March 26, 2009	39.9
6	Oct 6, 2009	11.6
7	Oct 13, 2009	10.4
8	Oct 19, 2009	15.7
9	Jan 27, 2010	24.3
10	Feb 26, 2010	44.1
11	March 29, 2010	6.3
12	April 20, 2010	14.7
Average		**20.4**

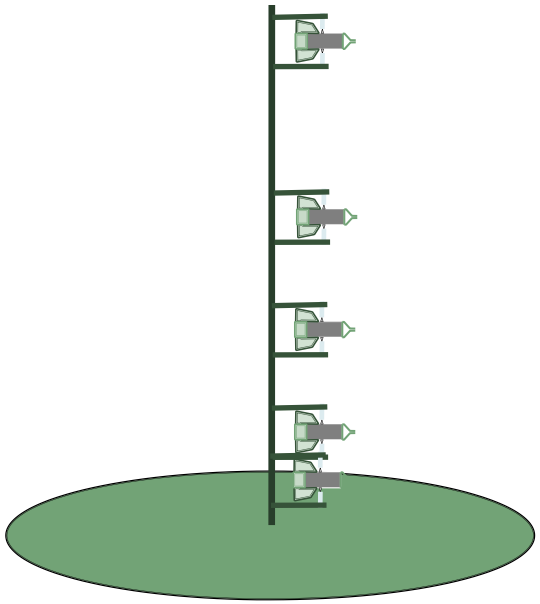
low N campaigns are not common

What about applying urea in front of air-drills?

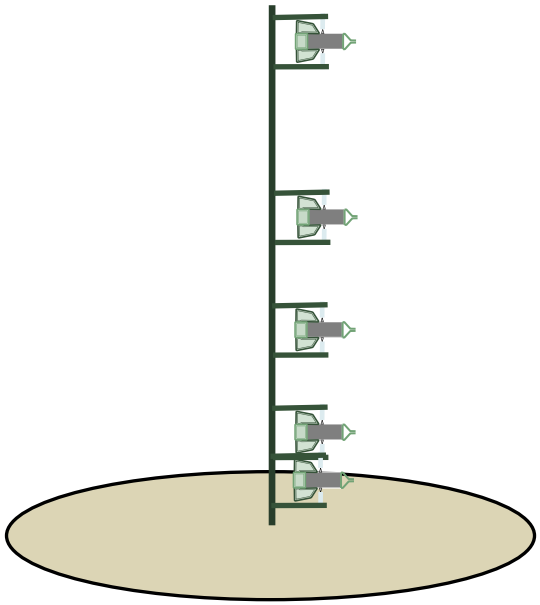
Fall Campaigns

What about applying urea in front of air-drills?

Fall Campaigns



pre-plant urea



post-plant urea
'control'

Kremlim site

Prills were covered - before

Prills were covered - after

What about applying urea in front of air-drills?

Three Campaigns this Fall

Fertilization date	Cooperator	Pre-seeding	Post-seeding
September 15	McIntosh- north Havre	18.7%	13.8%
September 27	McCormick - Kremlin	20.4%	24.4%
October 7	Peterson – Cottonwood	4.1%	5.2%

Future Plans

- winter applications – How cold does it have to be to stop ammonia volatilization losses from urea?
- preplant urea applications
- Goose Shooter – Kurt Kamberzell (Chester, MT)
- UAN

Winter 2011

- **Curtis Herschberger farm - Denton**

February 2, 2011

Summary comments

- significant N losses as NH_3 can happen in Montana when urea is surface-applied

- wet surface soil conditions w/o accompanying ppt → high risk for appreciable NH_3 loss, even if soil temperatures 28 to 41°F
  - ✓ greater potential for these conditions in Montana during late fall, winter (thaw), early spring
  - ✓ throw urea prills on the ground. Do they dissolve ?

- surface-applying urea to a dry soil surface is best, then hope for rain and wet snow that infiltrates into soil; some loss of N (10-20%) appears likely based on results to date

Summary Comments

- mid-winter urea on snow – 1 campaign on soil pH 8.4 (24.3% N loss) - may be problematic from NH_3 loss standpoint but we need to investigate further ??

- NPBT or Agrotain may have a role under the high loss potential conditions - longevity may be greater in calcareous soils

- surface-applying urea in front of air-seeder so far has not shown to be effective in suppressing volatility


Thank you for the support

Support

- Western Sustainable Agric. Research & Education program
- MT Fertilizer Advisory Committee
- MT Wheat and Barley Committee
- NRCS-CIG program
- International Plant Nutrition Institute
- Agrotain International
- AG Wise - Kremlin, Montana