Getting the most out of your N fertilizer $

Prepared for 2013 Montana/Wyoming Barley and Sugarbeet Symposium

by Clain Jones, Extension Soil Fertility Specialist
clainj@montana.edu; 406 994-6076

MONTANA STATE UNIVERSITY EXTENSION

Goals today

1. Discuss major potential N losses from an irrigated system and how to minimize
2. Present the effects of crop, fertilizer, and irrigation management practices on small grain yield and quality based on regional research

Potential losses

- Volatilization (ammonium → ammonia gas)
- Leaching
- Denitrification (nitrate → nitrogen gas)
- Immobilization (tie up by microbes; temporary)

High risk conditions for urea volatilization

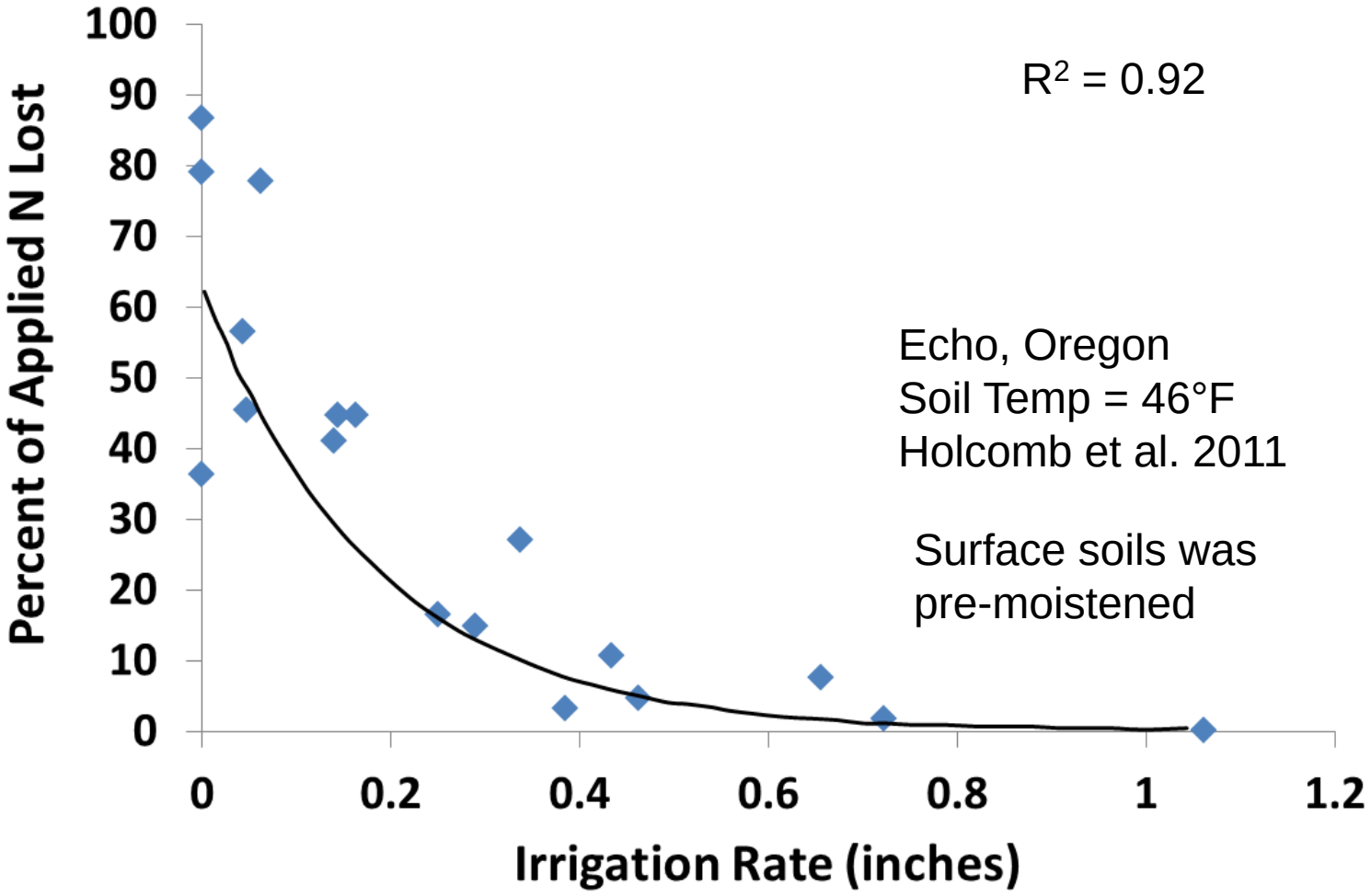
- Moist soil or heavy dew
- High soil pH (>7.0)
- High soil temperature (>70 °F) or frozen soil
- Crop residue, perennial thatch or sod
- Low cation exchange capacity soil (sandy)
- Poorly buffered soils (low soil organic matter, low bicarbonate content)

The risk of volatilization increases as the number of high risk conditions increase, with soil moisture likely being the most important.

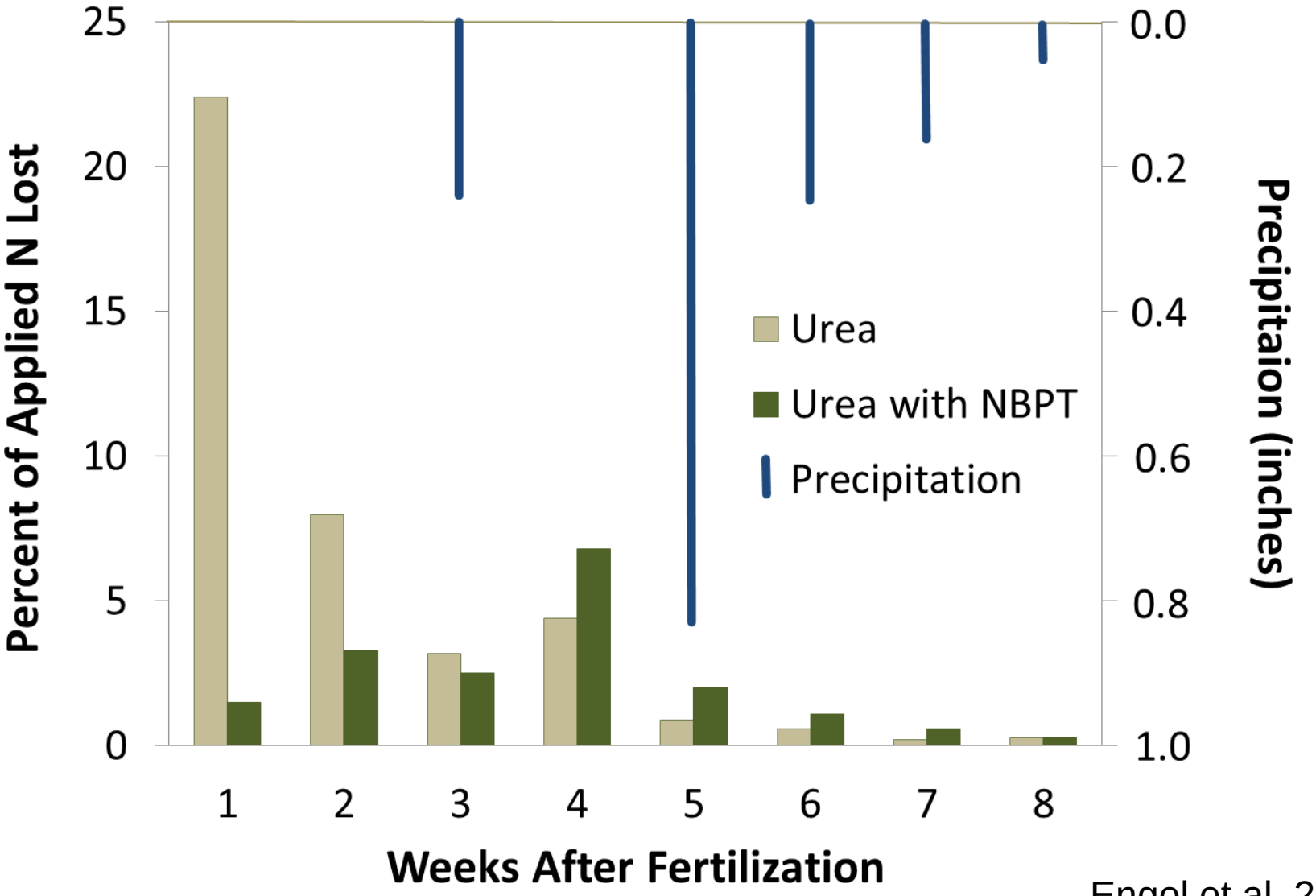
Practices to decrease volatilization from N fertilizers, especially urea

- Incorporate with tillage if possible
- Apply to dry, cool, but thawed ground
- Apply prior to a large (> 0.5”) moisture or irrigation event
- Use a protected product (e.g. Agrotain ®) if can’t apply during low risk periods or incorporate

Effect of irrigation amount on urea volatilization



Effect of rainfall on urea volatilization

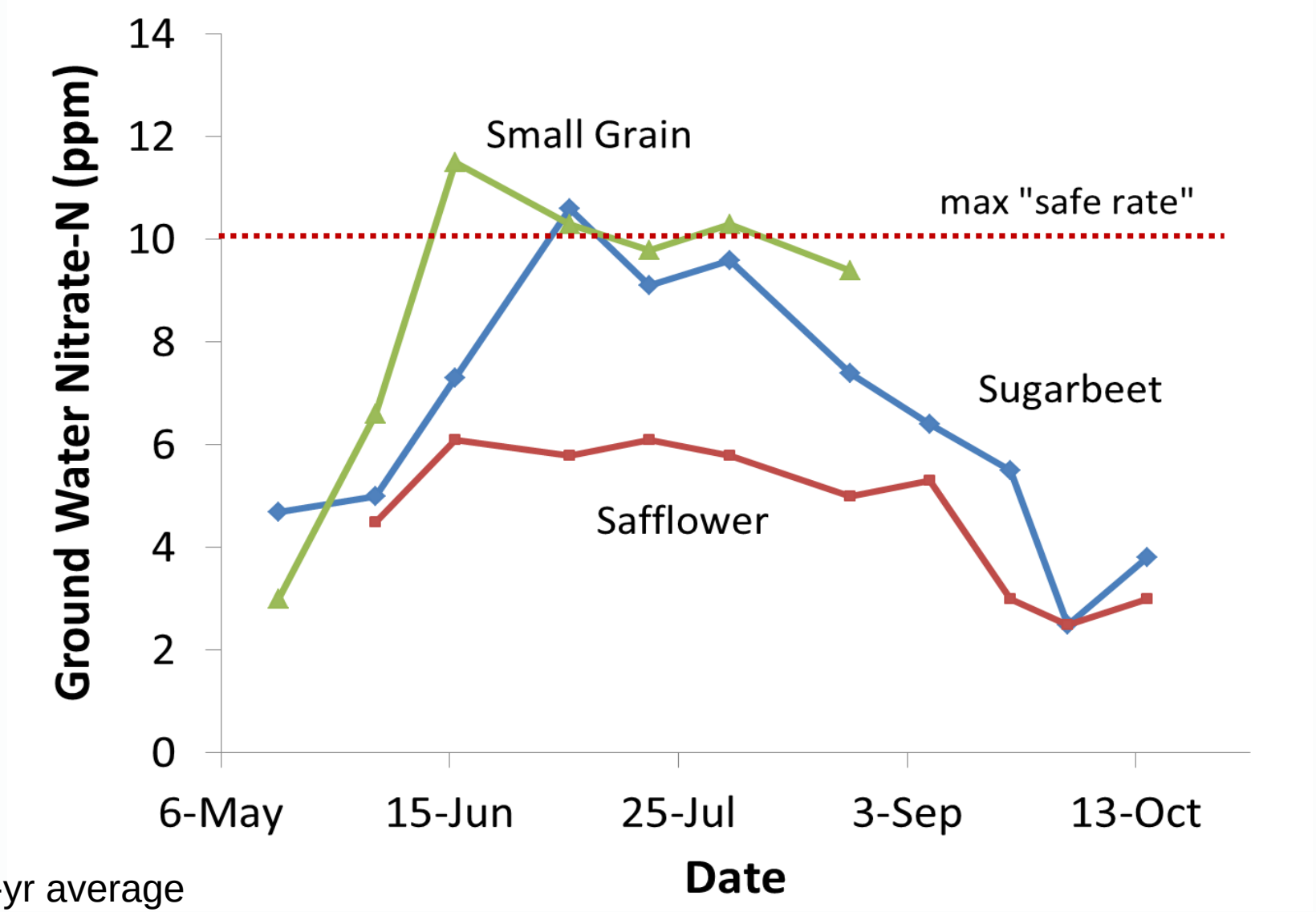


Engel et al. 2011

Conditions that favor nitrate leaching

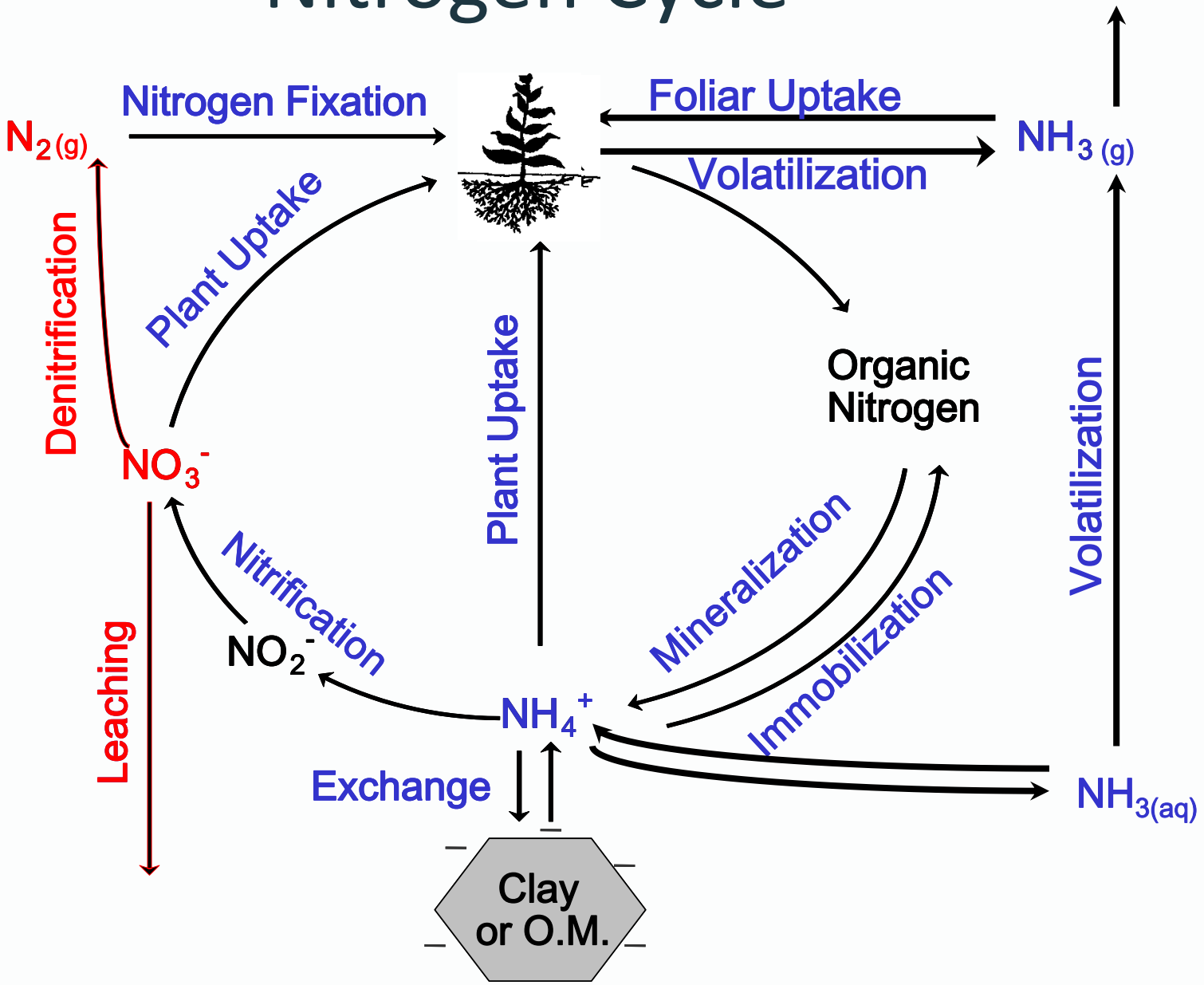
- Coarse, shallow soils
- Flood irrigation
- Shallow-rooted crops

Groundwater nitrate-N as affected by crop



6-yr average
Sidney, MT, Fertilizer Fact 9

Nitrogen Cycle



Conditions that increase denitrification

- Wet
- High organic matter
- High levels of nitrate
  - urea can take ~ 1 to 5 weeks to get converted to ammonium
  - ammonium can take ~1 to 3 weeks to get converted to nitrate
- WARMTH

Note: Can lose 1 to 5% of soil nitrate *per day* from saturated soils (Ransom, NDSU).

Crop and N management factors to decrease N leaching and denitrification

- Carefully manage irrigation
- Include perennial and/or deep rooted crops
- Consider legumes since don't need to fertilize w/ N
- Apply N based on spring soil test ESPECIALLY if have > 50 lb N/acre in fall AND soils less than 2 ft deep
- Split N application to match plant needs or use slow release N fertilizer
- Consider applying less N in areas that yield less or have soils that are shallow or pond (variable rate application)

Questions on volatilization, leaching, or denitrification?

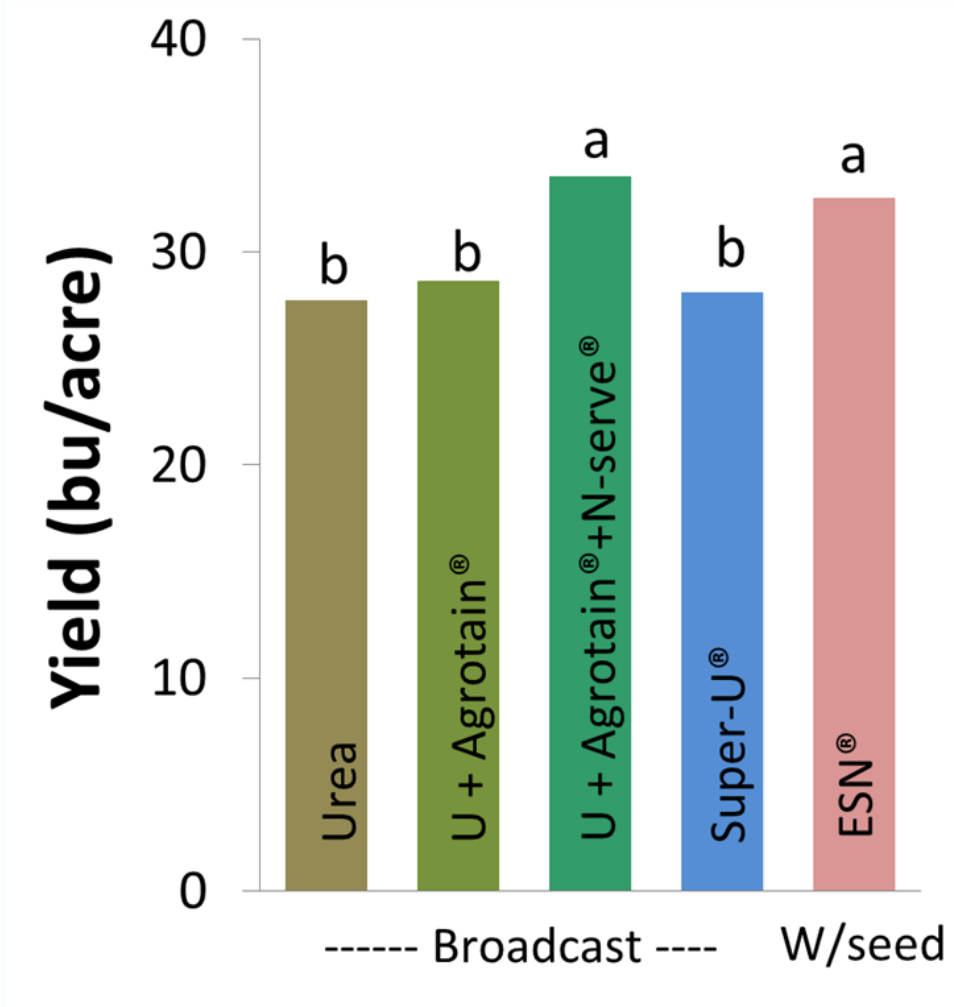
N Sources

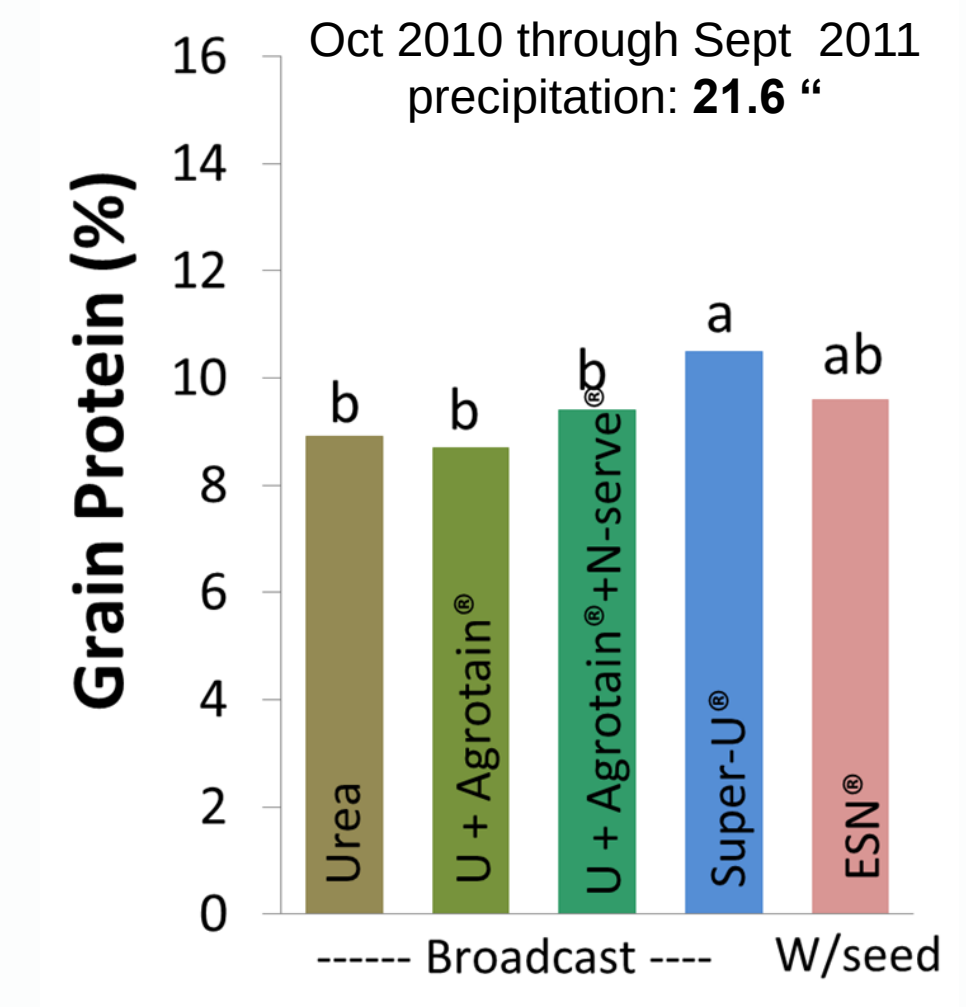
- Enhanced efficiency fertilizers
  - Urease inhibitors (ex: Agrotain® = NBPT)
  - Nitrification inhibitors (ex: N-serve®=nitrapyrin; Super-U® = NBPT + DCD)
  - Controlled release (ex: ESN® – polymer coated urea or PCU)
  - Slow release (ex: N-Demand, slowly degraded N)
  - Enhanced availability (ex: NSN®, NRG®)
- Urea vs Ammonium Nitrate vs Ammonium Sulfate

Source and timing study at Moccasin, MT

- Worst-case scenario for leaching – soils ~ 18” deep. 21.6” of precipitation from Oct 2010 to Sep 2011. Some similarities to irrigated system.
- Timing: Fall vs spring
- Placement: Broadcast, seed-placed
- Sources (selected, for all see Fertilizer Fact 62):
  - Regular urea
  - Super-U®
  - Urea mixed with Agrotain® and N-serve®
  - ESN with seed (only in fall)

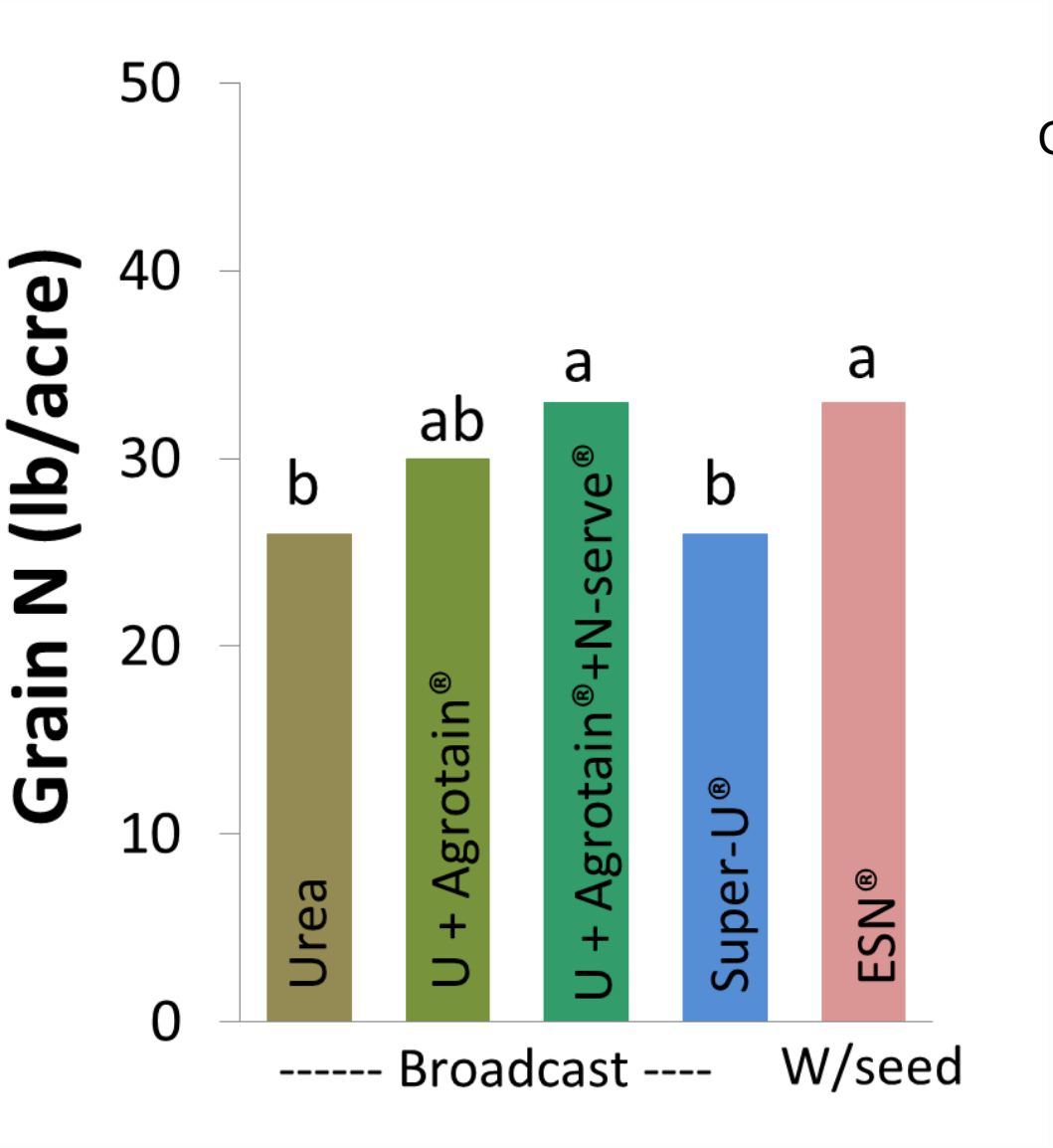
Fall N source and placement on winter wheat grain yield and protein under high risk leaching conditions





Fertilizer Fact 62, Moccasin, MT

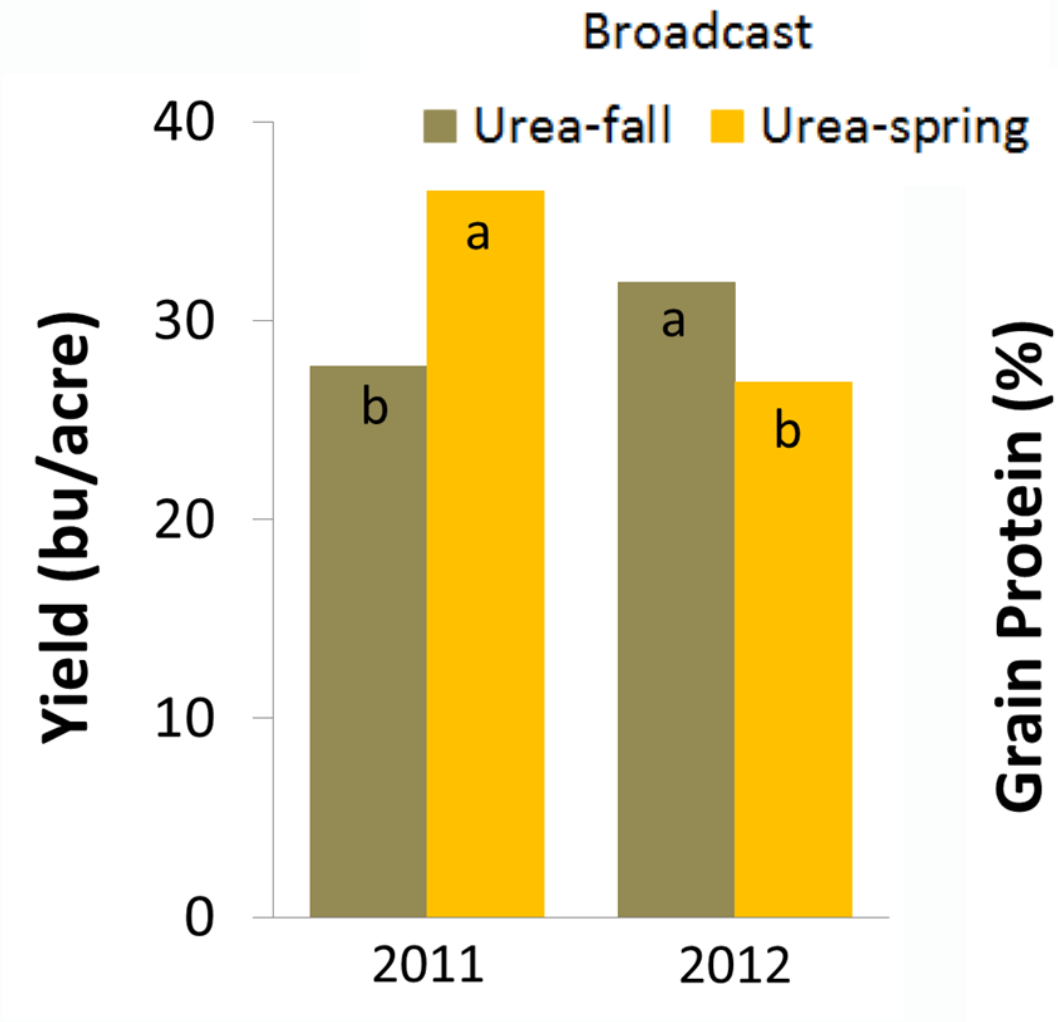
Fall inhibitor effect on winter wheat grain N (2011)



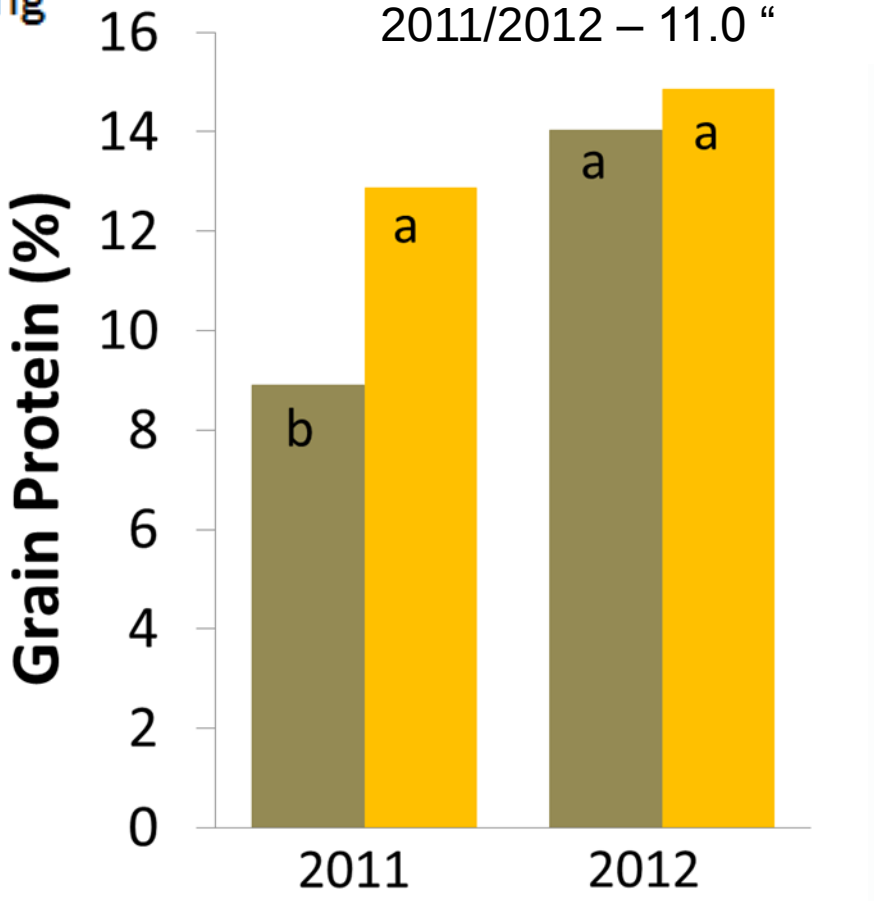
Oct through Sept precipitation
2010/2011 – 21.6 “

Fertilizer Fact 62
Moccasin, MT

Effect of N application timing on winter wheat grain yield and protein

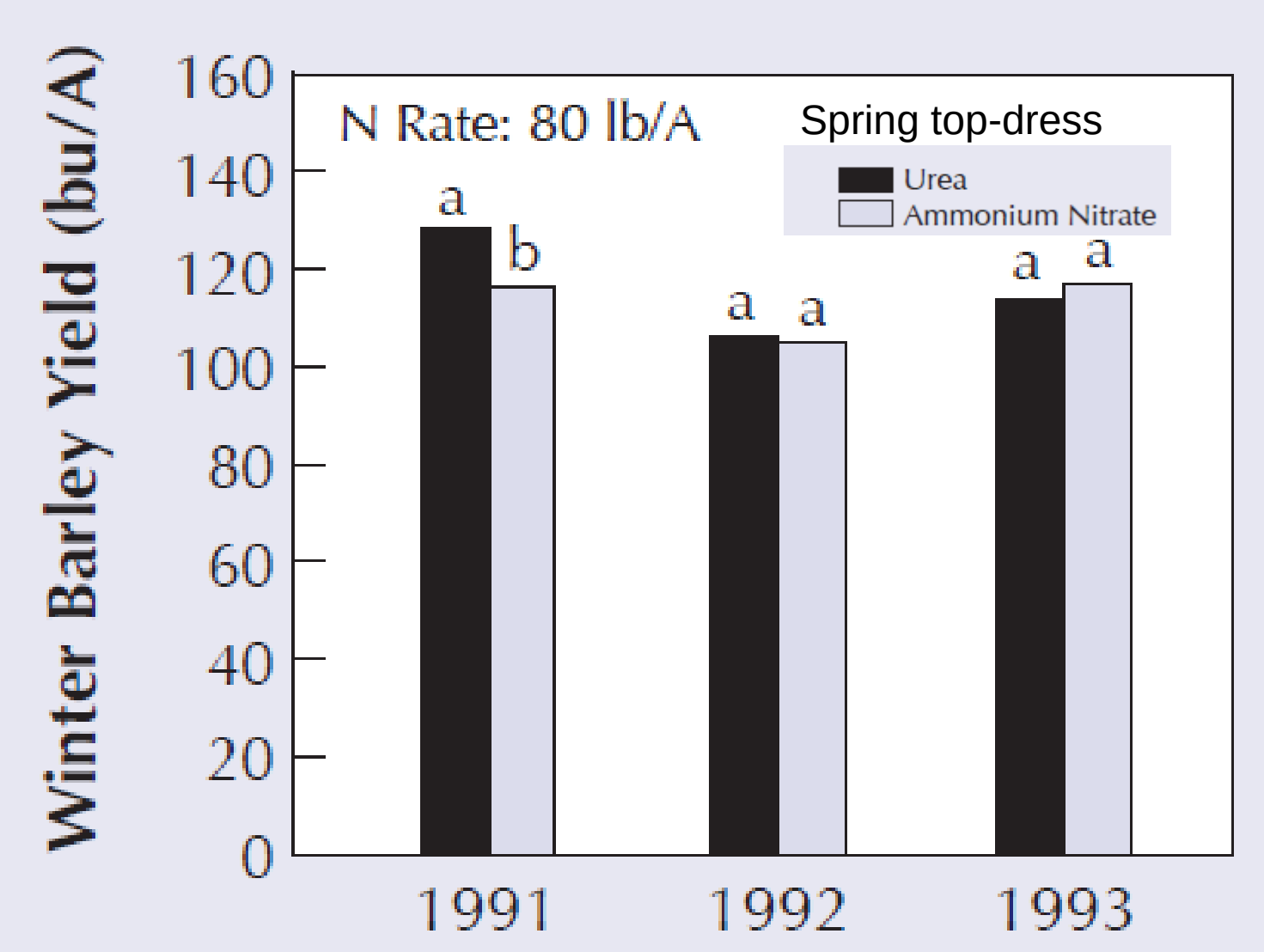


Oct through Sept precipitation
2010/2011 – 21.6 “
2011/2012 – 11.0 “



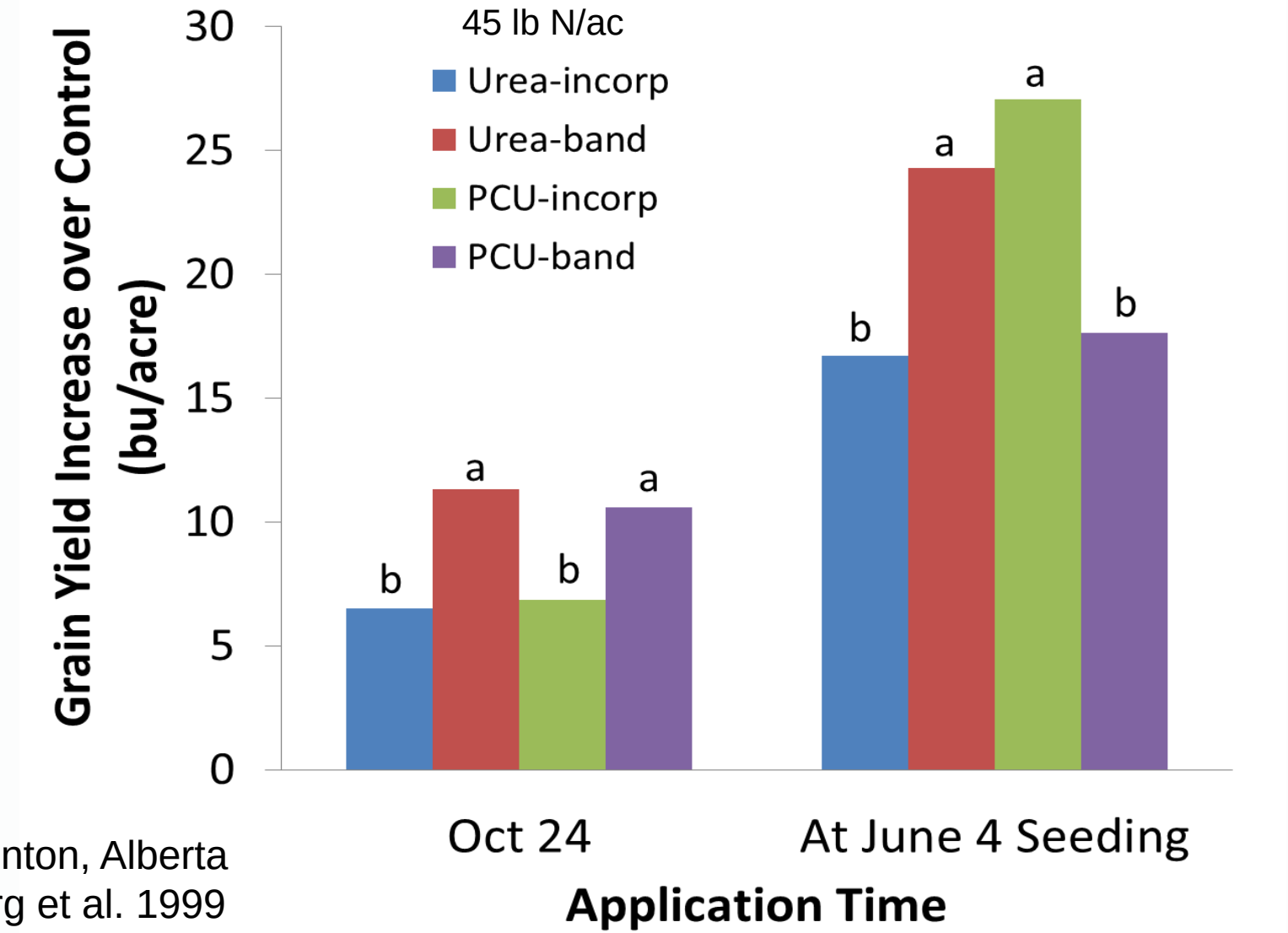
Fertilizer Fact 62, Moccasin, MT

Source effect on barley yield



Idaho, Brown unpub. data

Timing, placement and N source on barley grain yield and N uptake

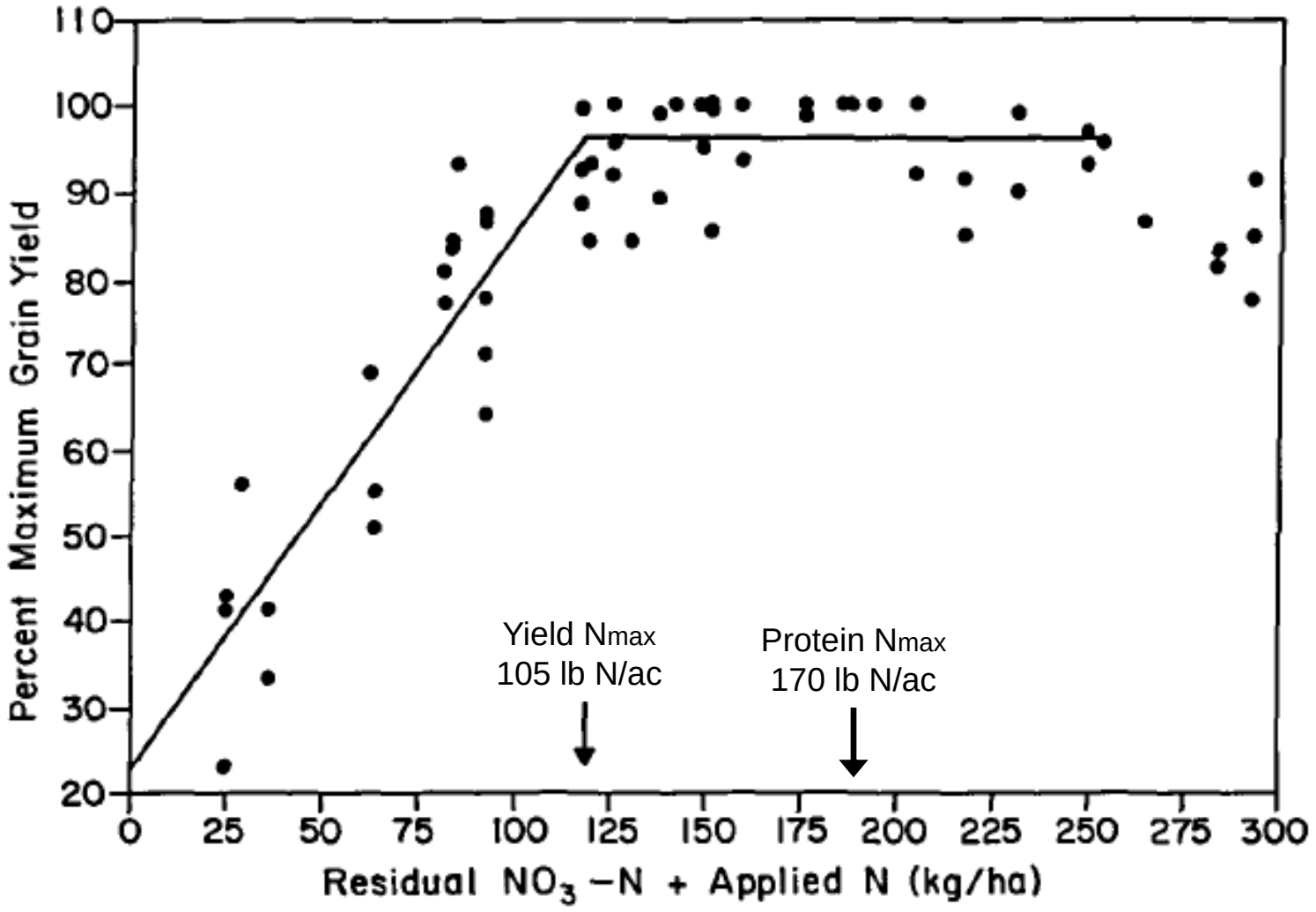


Edmonton, Alberta
Nyborg et al. 1999

Questions on fertilizer source, placement & timing?

N Rate

Irrigated barley yield response to available N

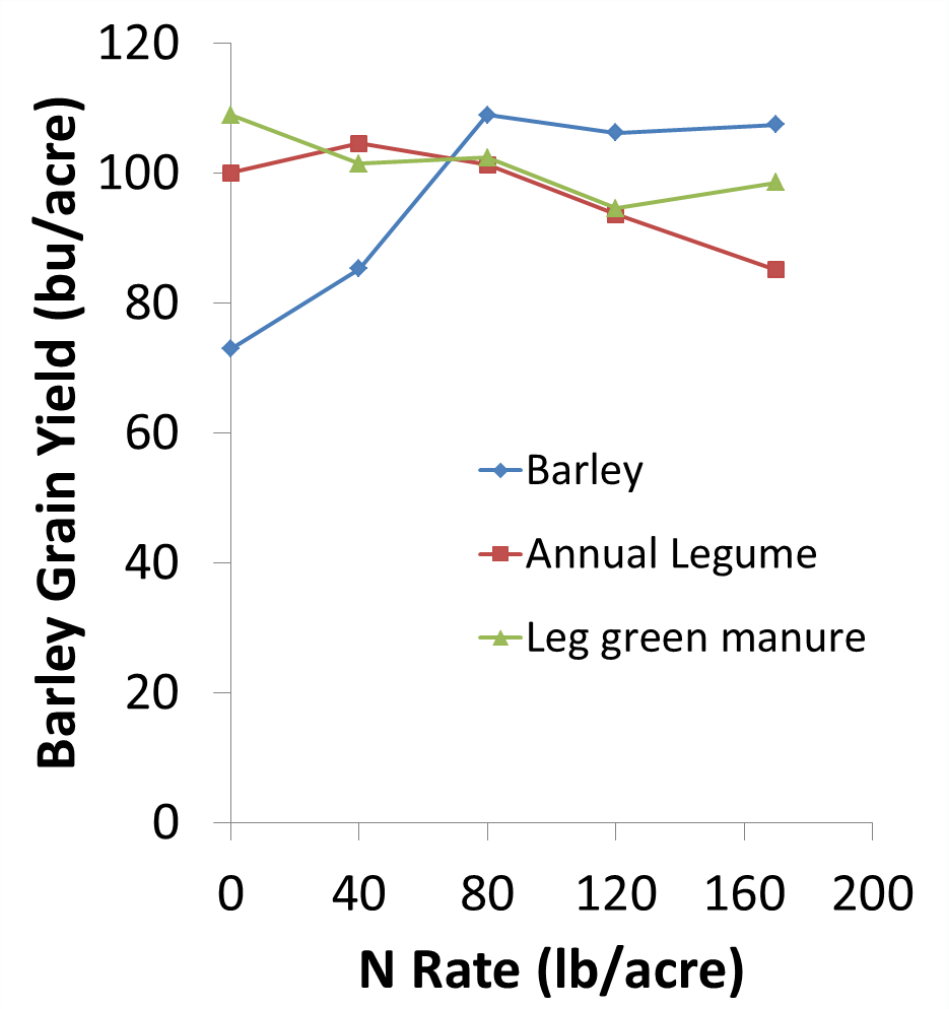


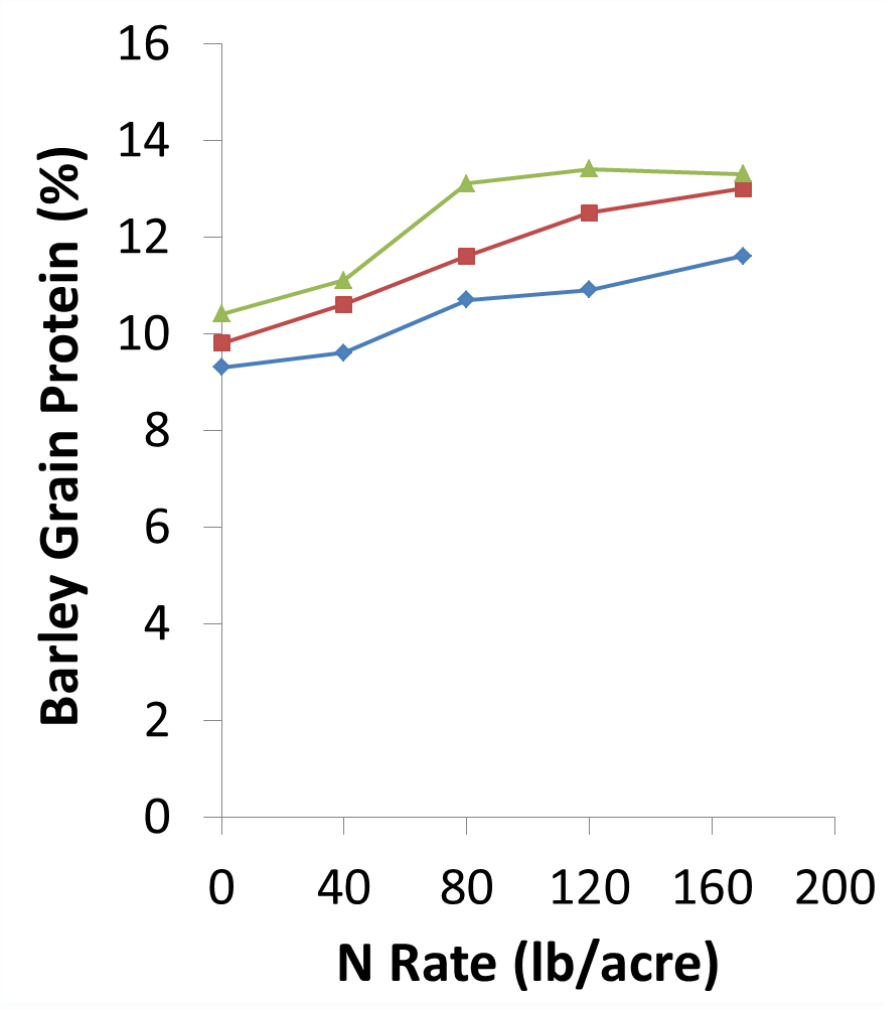
Idaho, Stark and Brown 1987

Questions on fertilizer rate?

Rotation

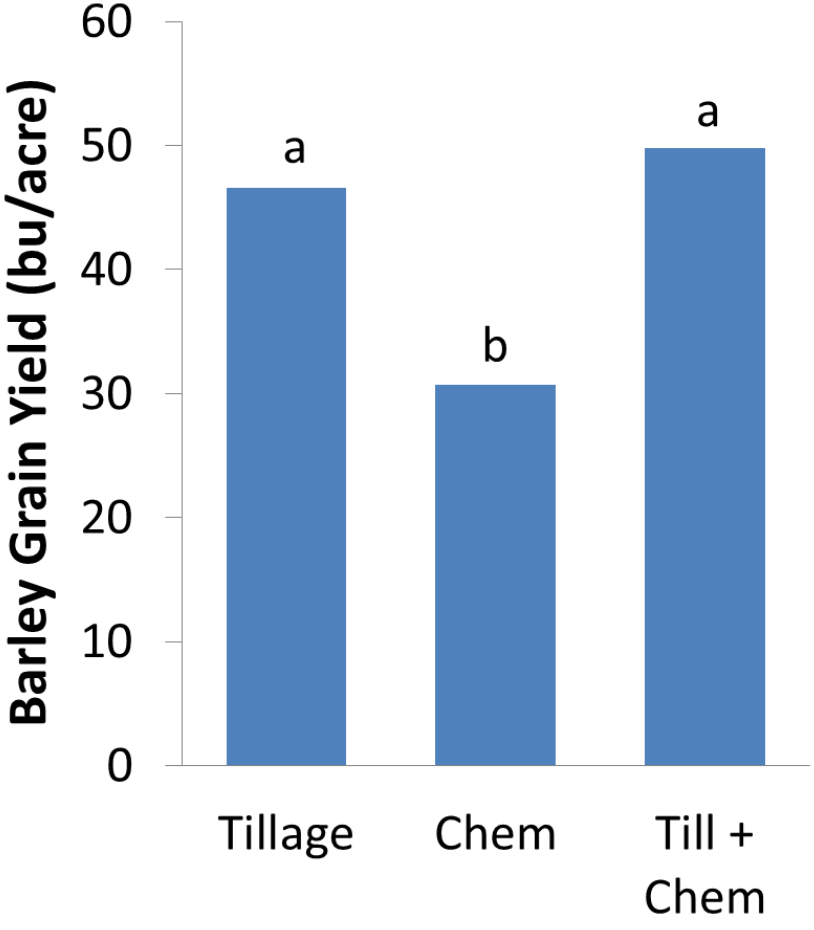
Prior crop effect on irrigated barley yield and protein

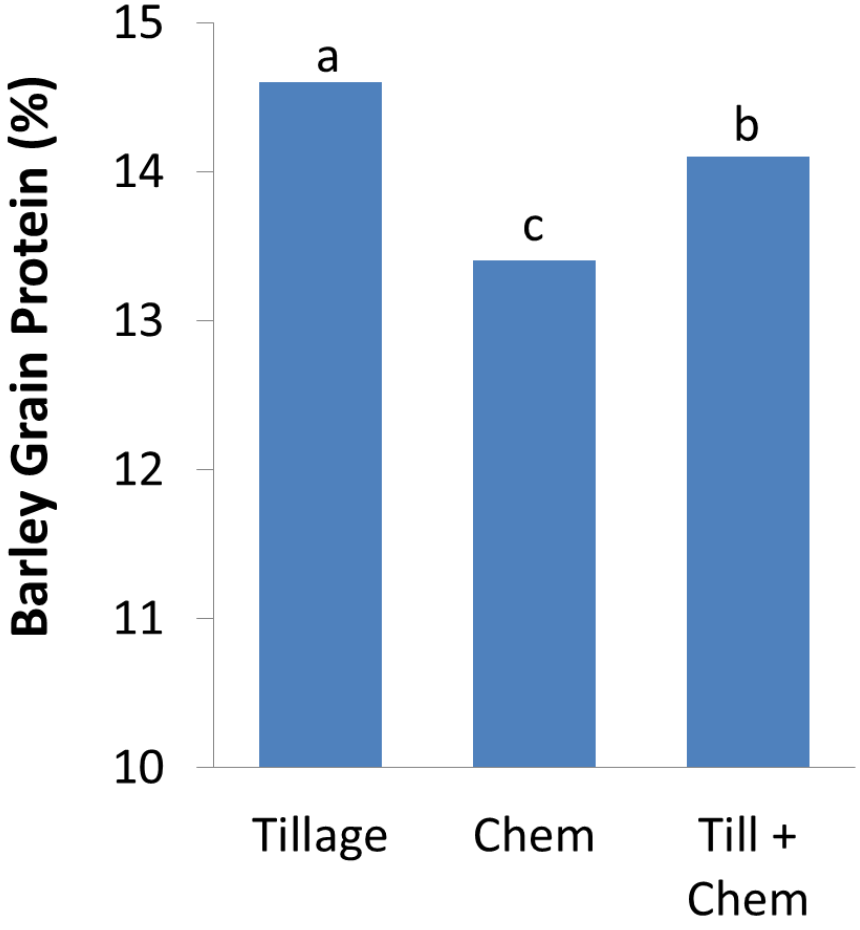




Huntley, MT, Welty et al. 1988, McGuire et al. 1989

Alfalfa termination method effect on barley yield and protein





Termination Method

NE Saskatchewan, Malhi et al. 2007

Tools

MSU Soil fertility recommendations

http://www.sarc.montana.edu/php/soiltest/

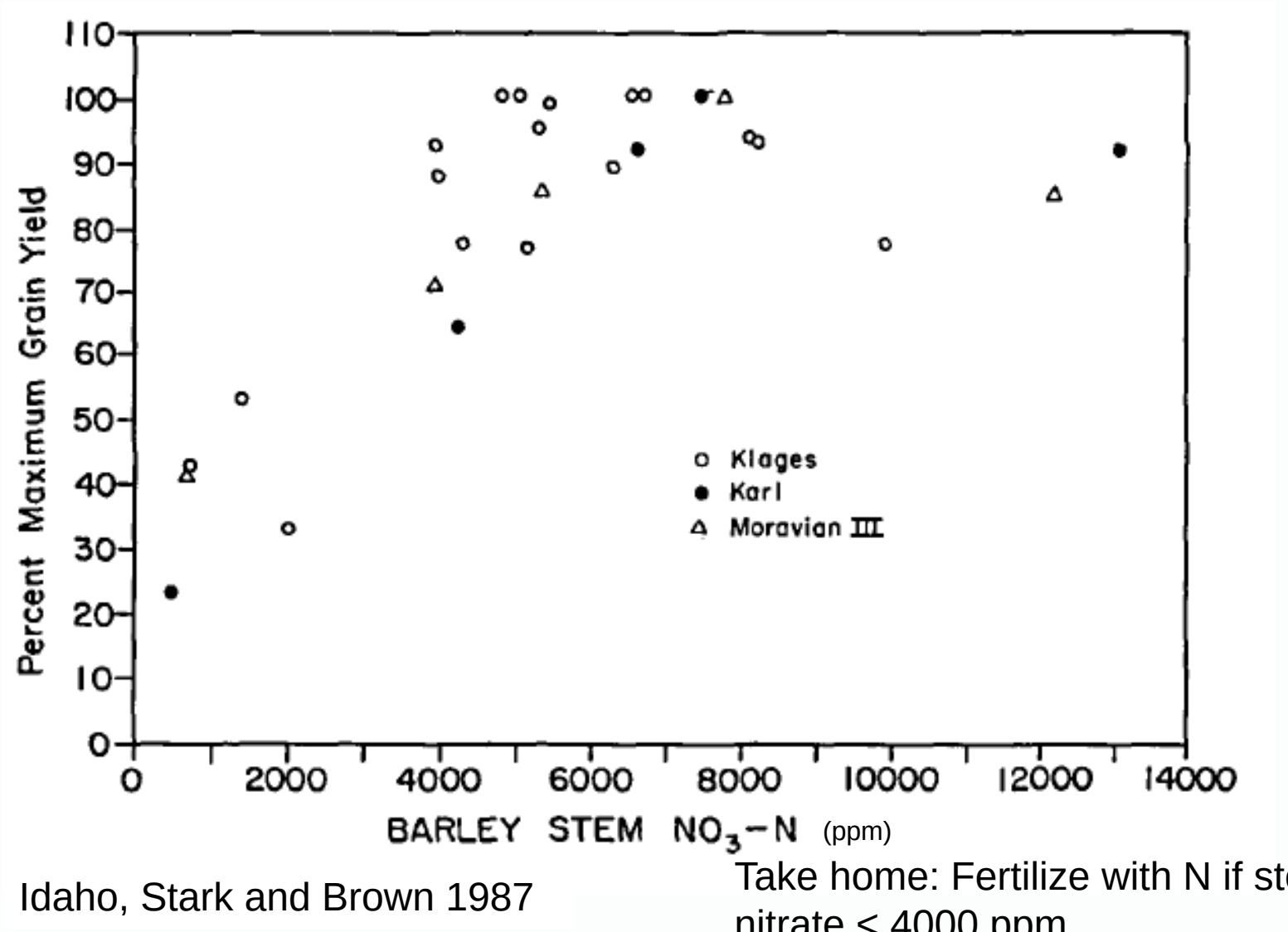
Submit Clear form

1. Topsoil sample results:			2. Soil Nitrate Results:				
Olsen P	6	ppm	Sample #	top	bottom	Soil test value	
Extractable K	50	ppm	1	0	6	60	ppm
Soil Organic Matter	1.5	%	2	6	12	65	
			3	0	0	0	
			4	0	0	0	

3. Crop Management:		
Last year's crop: sugarbeet	New Crop barley-malt	Yield goal of 80 bu/acre

Submit

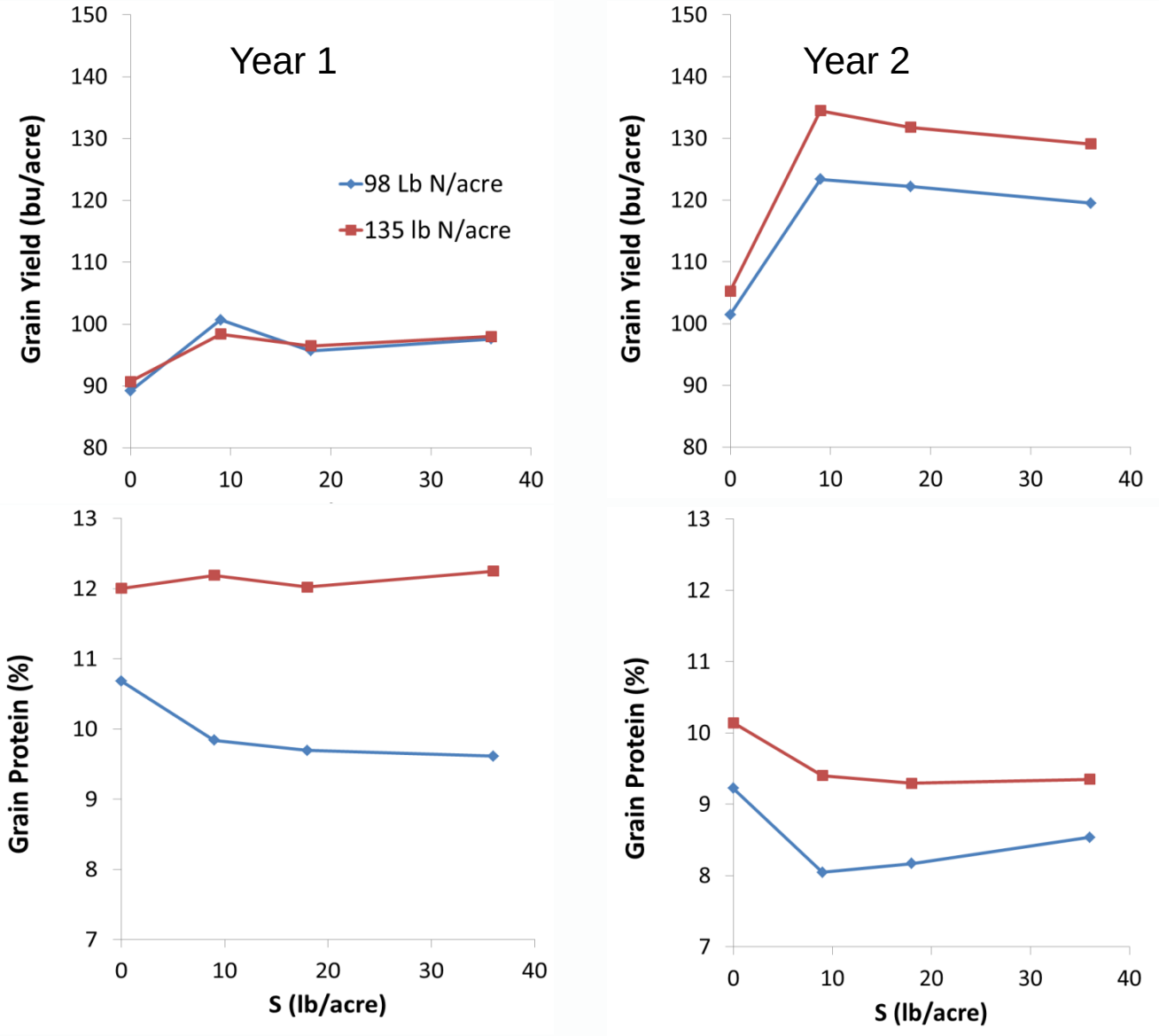
Irrigated barley sufficiency stem nitrate-N at 3-leaf stage



Idaho, Stark and Brown 1987

Take home: Fertilize with N if stem nitrate < 4000 ppm.

Sulfur affects barley yield and protein



England
Zhao et al. 2006

Conclusions

- In a wet year, controlled release and stabilized urea produced higher yields than conventional urea when fall applied
- Spring urea application often produced higher yields than fall applied urea or enhanced products
- Surface broadcast urea should either be immediately incorporated to prevent volatilization or treated with NBPT. Use at least 0.5 inches of irrigation to incorporate.
- Legumes can reduce the need for added N and deep rooted crops are important to scavenge N deep in the soil profile
- Tools are available to calculate pre-plant N rates or potential in-season N adjustments
- S is needed for efficient use of N

For additional information

Soil Fertility Website:

http://landresources.montana.edu/soilfertility

Contains links to my presentations including this one, economic N rate calculator, fertilizer facts, press releases, Extension publications, etc.

QUESTIONS?