

Tonight's host and co-host



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Soil Fertility for Forages

Winter Soil Fertility Series: Week 5

Feb 3, 2021

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Photo by K. Olson-Rutz

Welcome MSU's new Extension Forage Specialist

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EXTENSION

Why learn about soils?

- For good forage yields, and cover for livestock and wildlife
- For efficient use of resources (water, fertilizer, \$)
- For conservation




Image by K Olson-Rutz

Goals



- Show nutrient deficiency symptoms of nitrogen, phosphorus (P), potassium (K) and sulfur
- Review use of Fertilizer Guidelines to determine fertilizer rates
- Present timing, source and placement considerations
- Illustrate yield and quality responses of hay to P, K, and S
- Help your bottom line

Some questions for you. I will copy and paste these into Chat, and then you can respond with Y for Yes or N for No



Who has raised alfalfa-hay or grass hay?

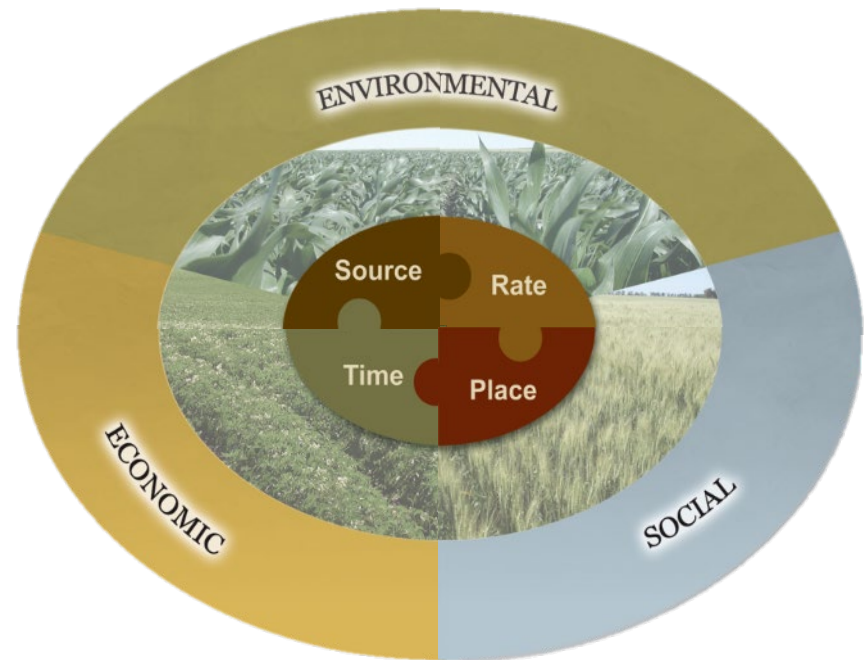
Who has pasture?

Who has grown annual forages (ex: Haybet barley, Willow Creek winter wheat)?

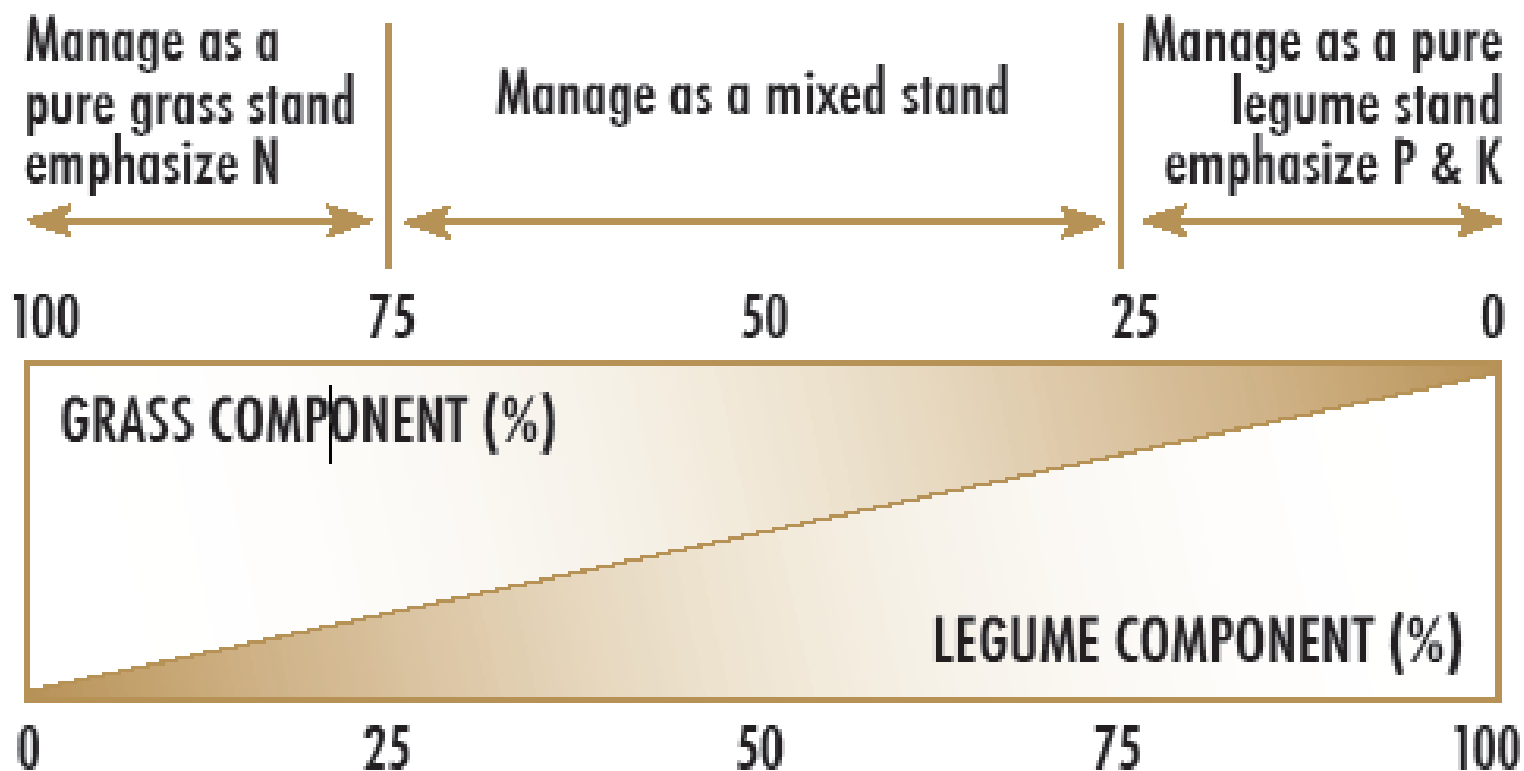
To get the most out of your fertilizer investment

The 4 Rs:

- Right rate
- Right source (including legumes)
- Right timing
- Right Placement
- (Right Rotation)

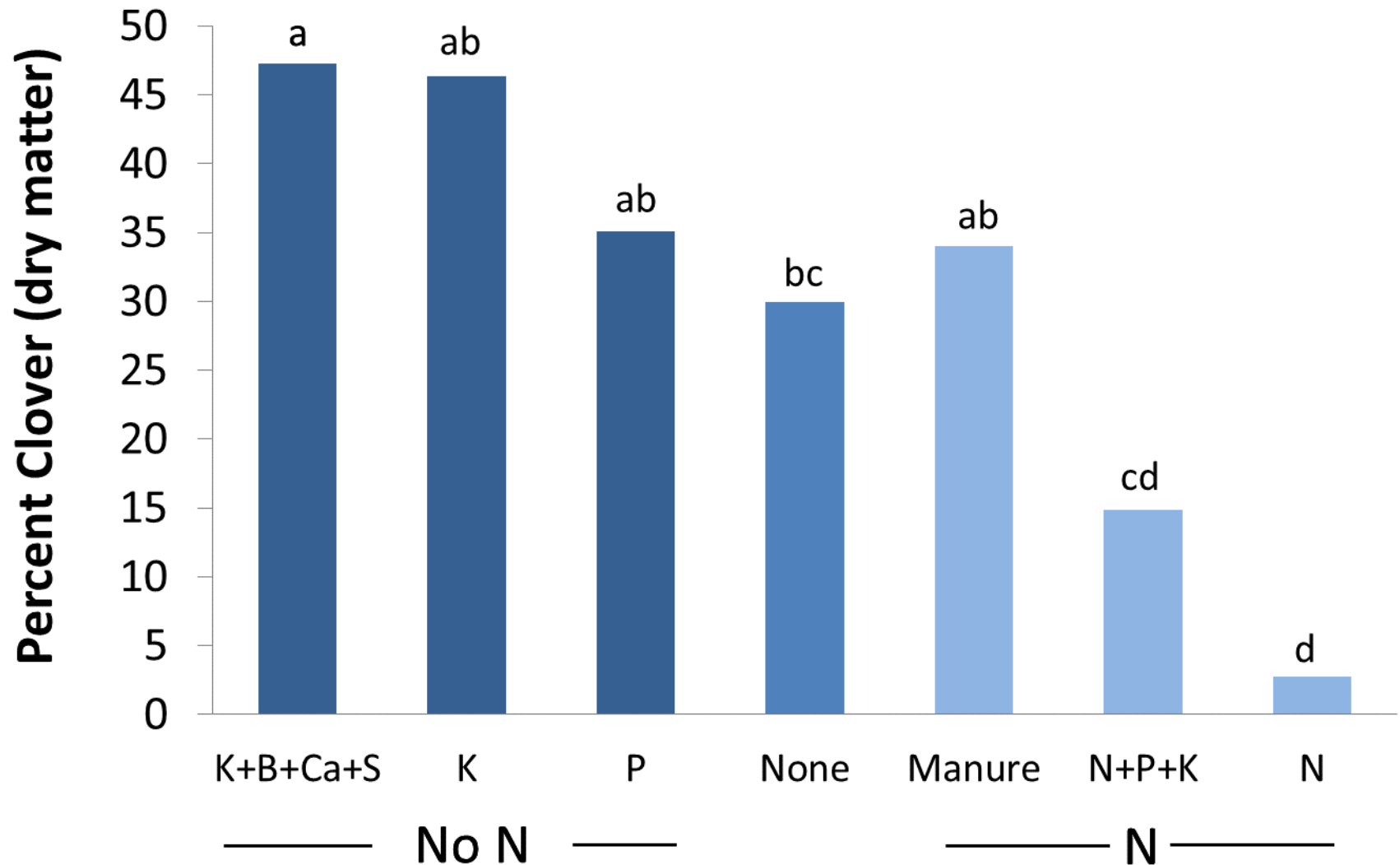


Focus of N or P and K depends on % legume in stand



Yield increases and net returns with N greatest if < 36% alfalfa in stand and soil N < 5 lb N/acre (Malhi et al. 2004)

Fertilizing with nutrients other than N favors legumes over grass (w/in 3 yrs)



Questions?



On to Nitrogen (N)

N Deficiency Symptoms

1. Pale green to yellow lower (older) leaves.
Why lower leaves? N is 'mobile' in plant
2. Stunted, slow growth
3. Few tillers in small grains

➤ In Nutrient Management Module 9
<https://landresources.montana.edu/nm/>

➤ Online
<https://landresources.montana.edu/soilfertility/nutrientdeficiencies.html>



Corn



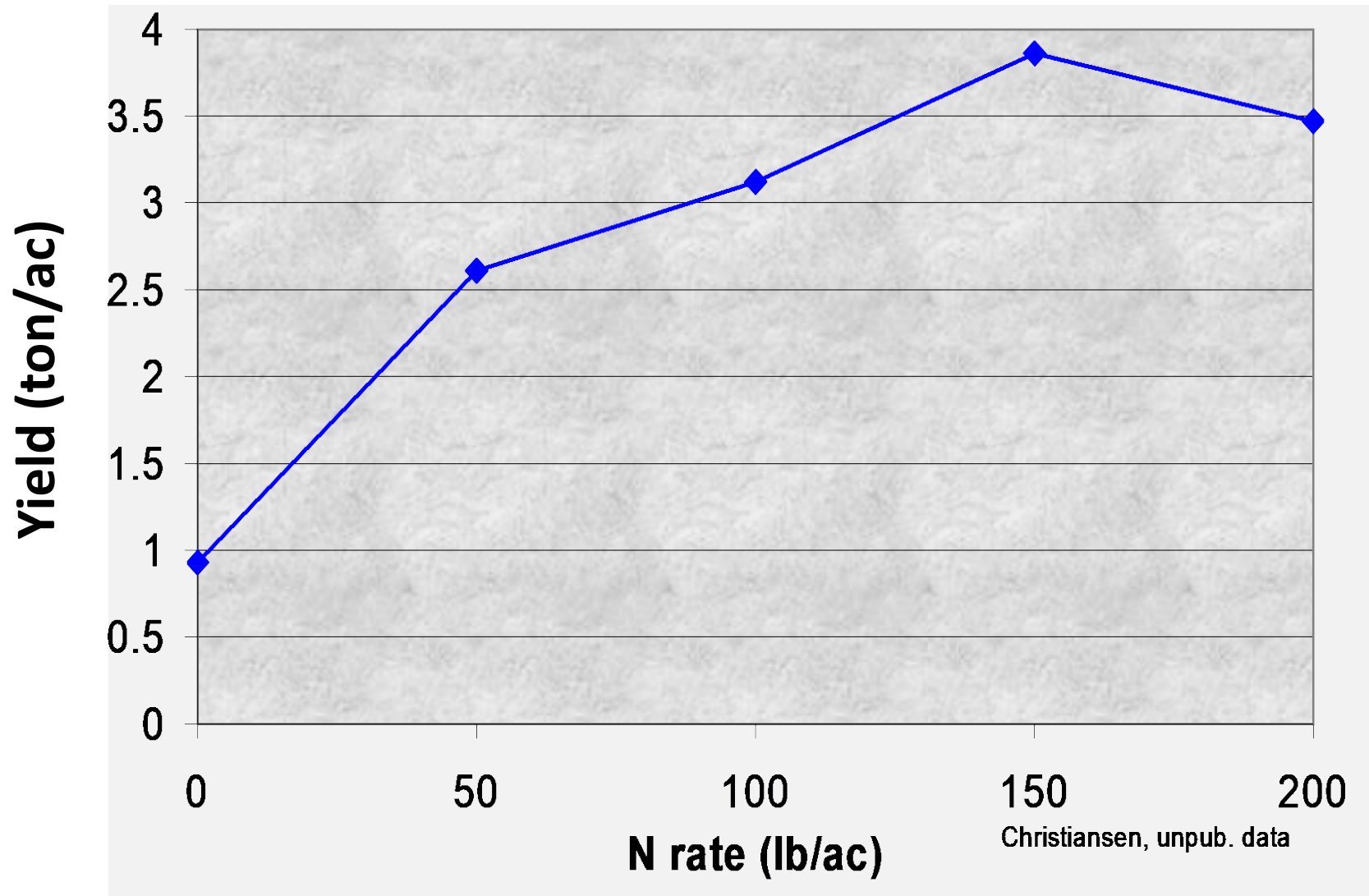
Alfalfa



Image by DairyNZ

Diminishing return of increasing N

Applies to all crops, example on irrigated western wheatgrass, Blaine Co.



Example N calculation: Forage

- Know your yield goal. Use 5 ton of 20/80 legume/grass mix, and 4 lb N/ac soil test value for this example
- Compare soil test to MT guidelines

	Alfalfa/Grass			
	80/20	60/40	40/60	20/80
Yield (ton/ac)	Available N (lb/ac) need			
1	5	10	15	20
2	10	20	30	40
3	15	30	45	60
4	20	40	60	80
5	25	50	75	100
6	30	60	90	120

How much
fertilizer N?

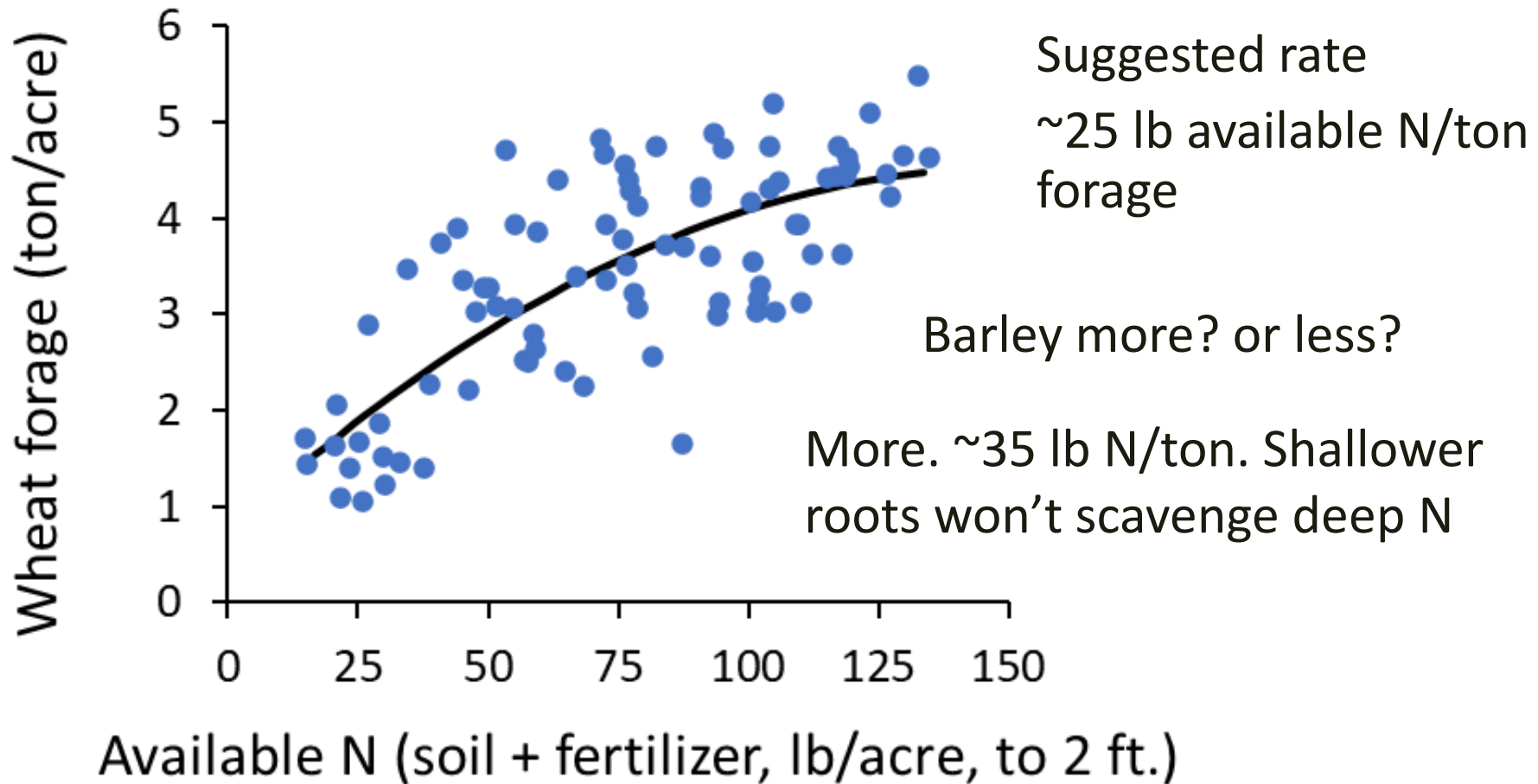
Fertilizer N =

Available N needed
– soil test N

$$100 - 4 = 96 \text{ lb N/ac}$$

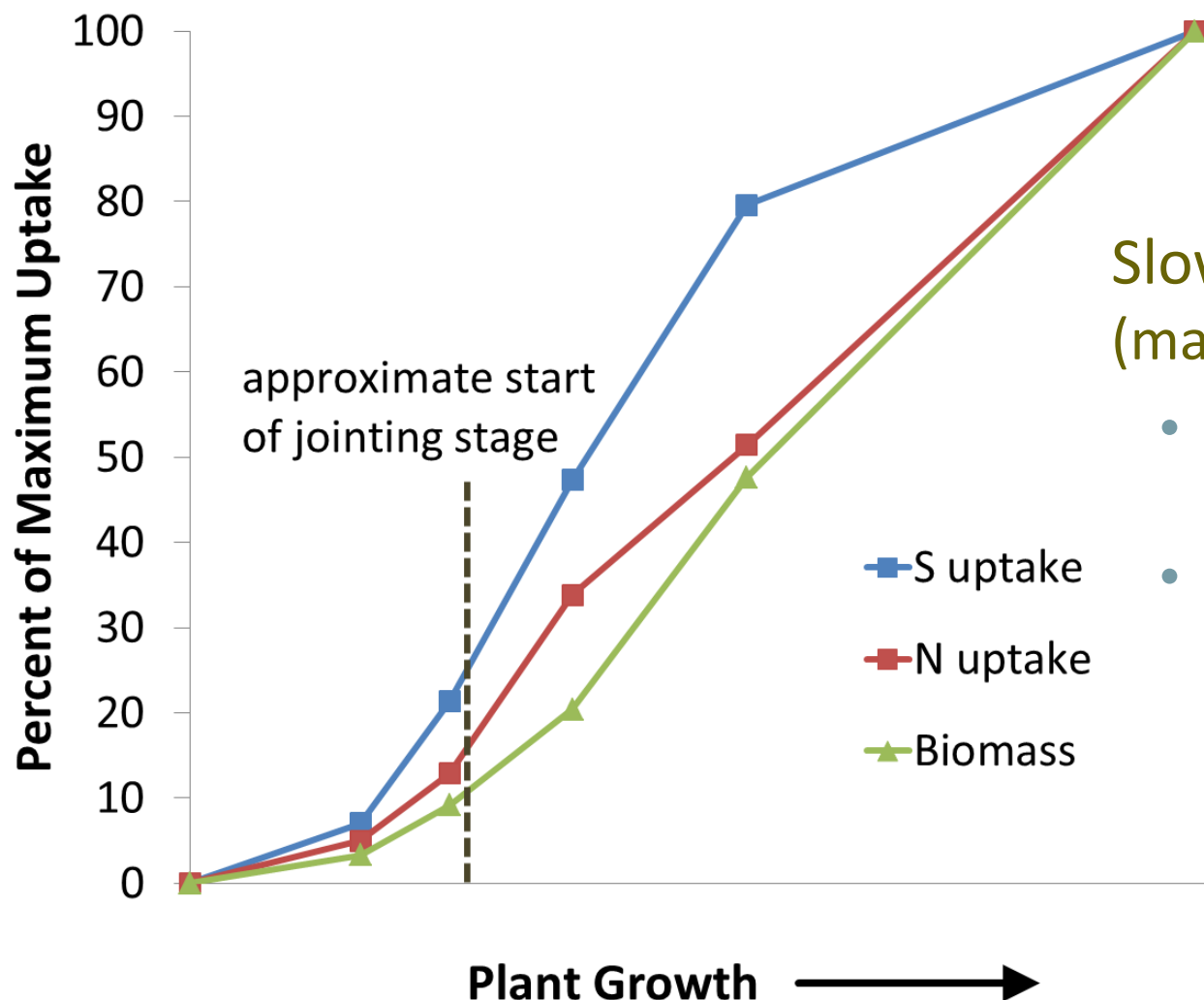
Total available N (soil + fertilizer) needed for dryland winter wheat forage at 2 MT sites

Averaged over 4 N rates, broadcast and banded, 3 years



Optimal timing depends on source

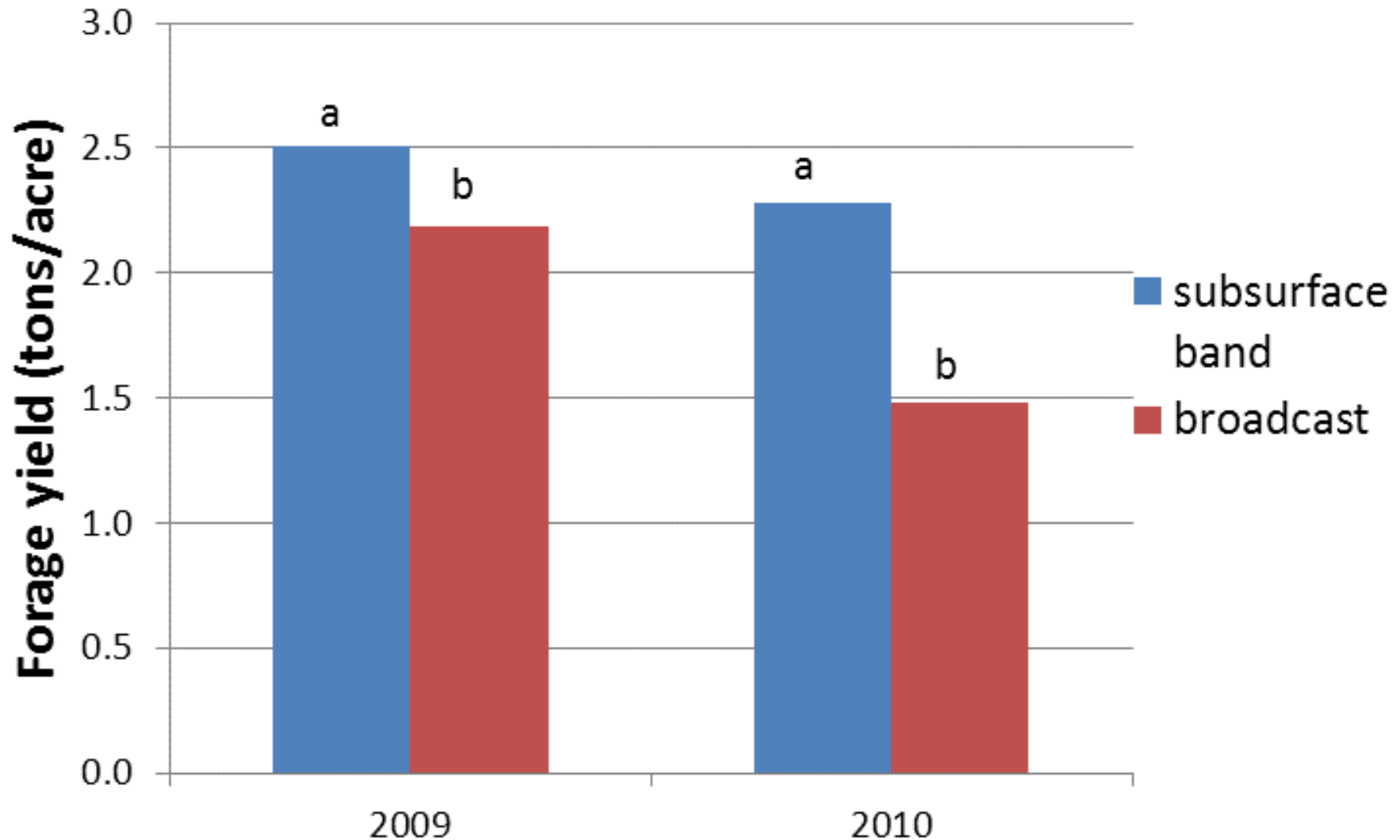
Readily available N (urea, UAN): shortly after **GRASS** green-up



Slowly available N
(manure, slow-release N)

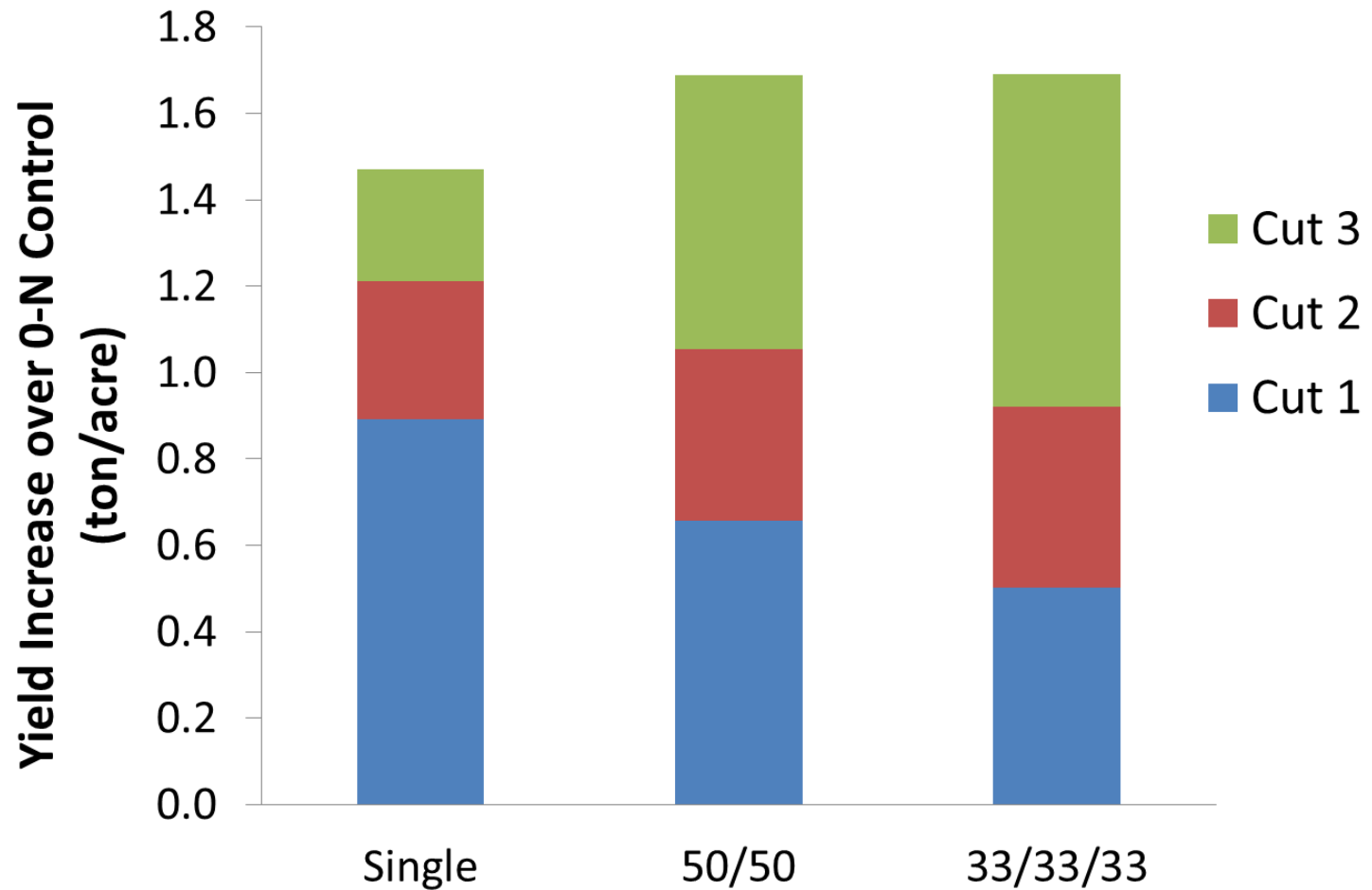
- take time to become available
- apply well before needed – e.g. fall

Urea placement affects Hays barley forage yield



Angvick et al. unpub data, Froid, MT

Split app may increase total yield, improves distribution over season



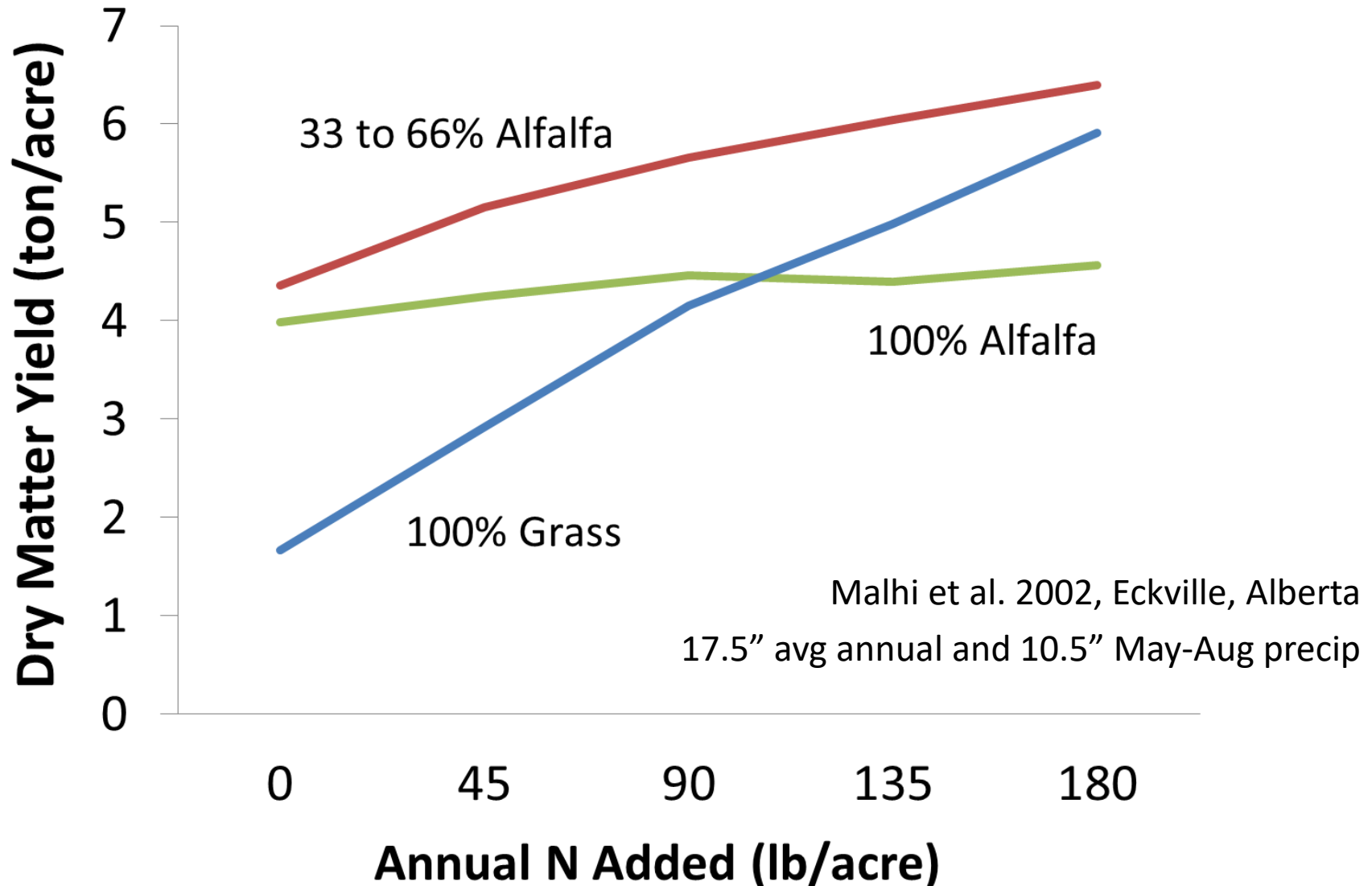
Lacombe, Alberta
Dryland brome-grass
Malhi et al. 2002

N Application Timing

averaged over 53, 106 and
160 lb N/ac rates and 3 yrs

Early spring alone, or split btwn. early spring and after 1st, or 1st and 2nd cutting

Adding N – having alfalfa in mix may be best source of N



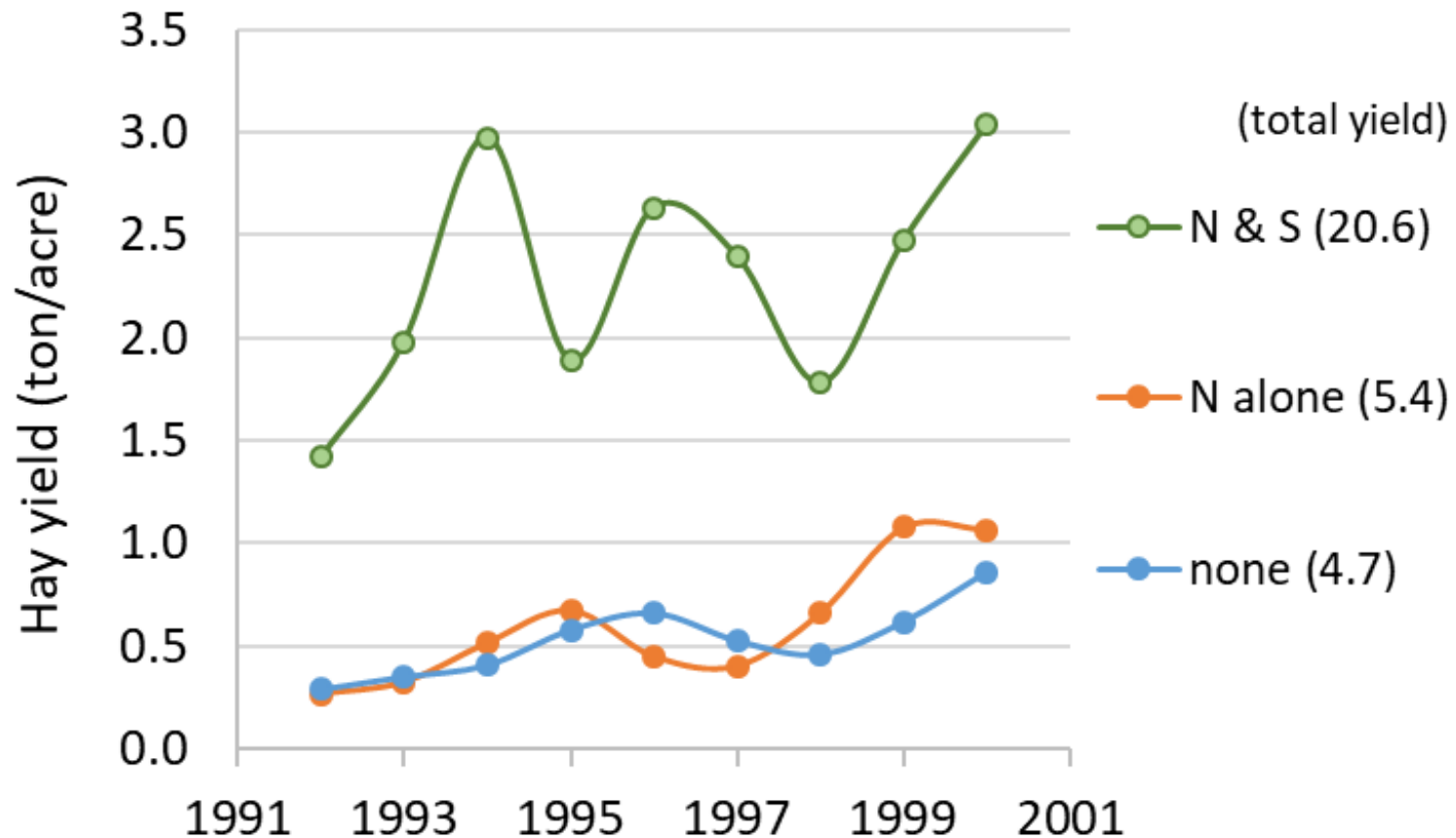
Questions?



*On to Sulfur (S), Phosphorus (P)
and Potassium (K)*

Balanced N and S fertilization increases yield in mixed dryland brome hay

Started in 1980, annual spring surface broadcast 100 lb N/ac as ammonium nitrate and 9.8 lb S/ac as sulfate



Sulfur

- Eroded or coarse-textured soils are more susceptible to sulfur deficiency, particularly after high rainfall
- Alfalfa is S deficient at tissue concentrations $<0.25\%$ (leaves from top 1/3 of plant at budding). For other forages contact testing lab or see our Extension documents
- $S > 0.30\%$ can cause livestock health problem
- Deficiencies increasing. S fertilizer increased alfalfa yield ~ 3 fold in Moccasin area (Wichman, unpub data)

Sulfur visual symptoms are better than soil tests

- Standard sulfate soil test too unreliable
- Visual symptoms
 - yellow or light green **upper** leaves
 - Small thin stems
 - Delayed maturity
 - No characteristic spots or stripes
- Last year production performance

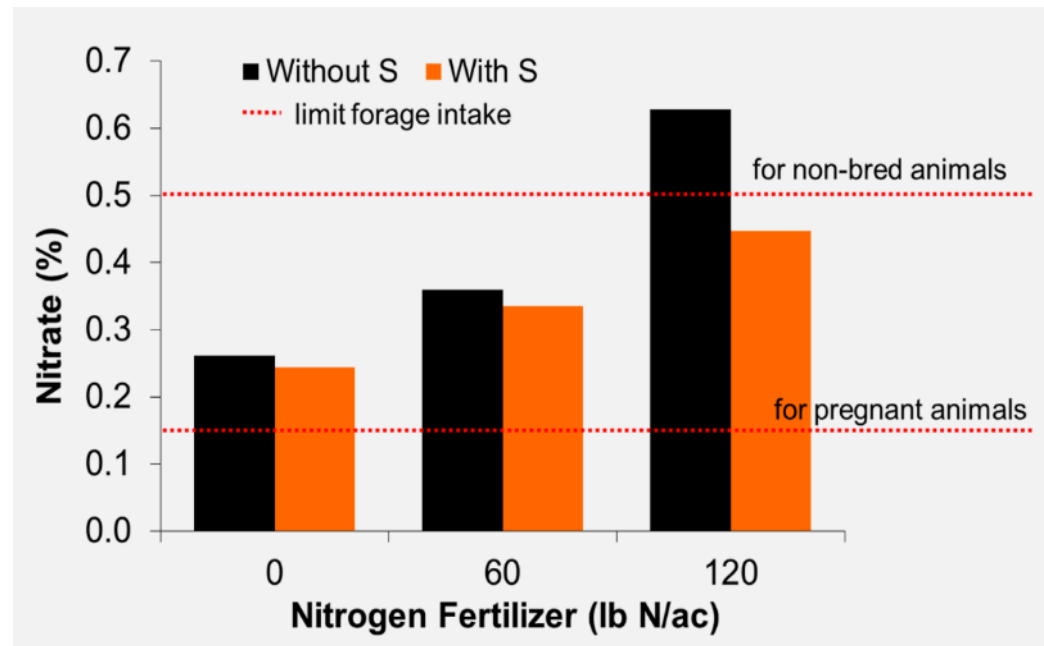
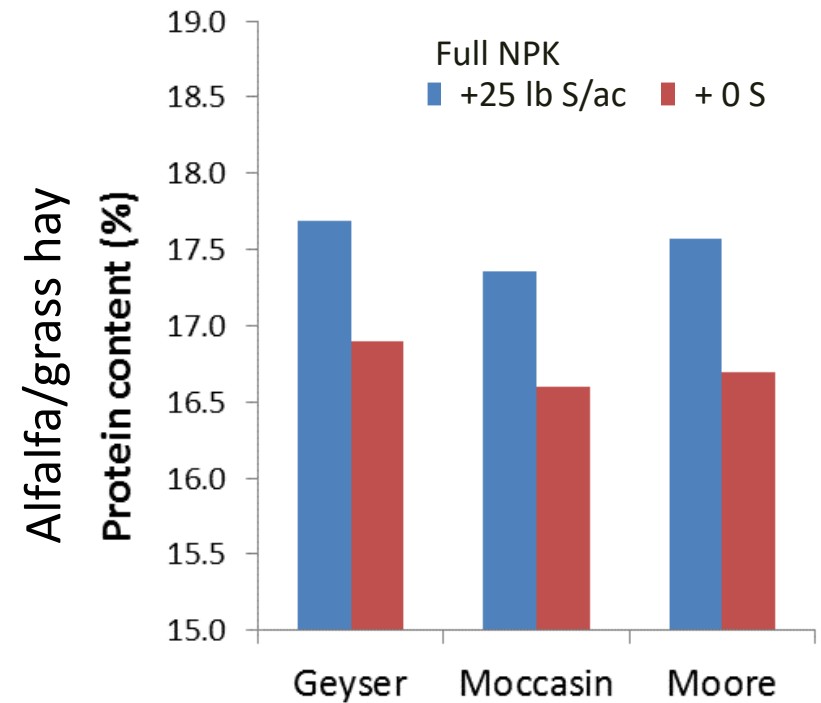


Images from IPNI

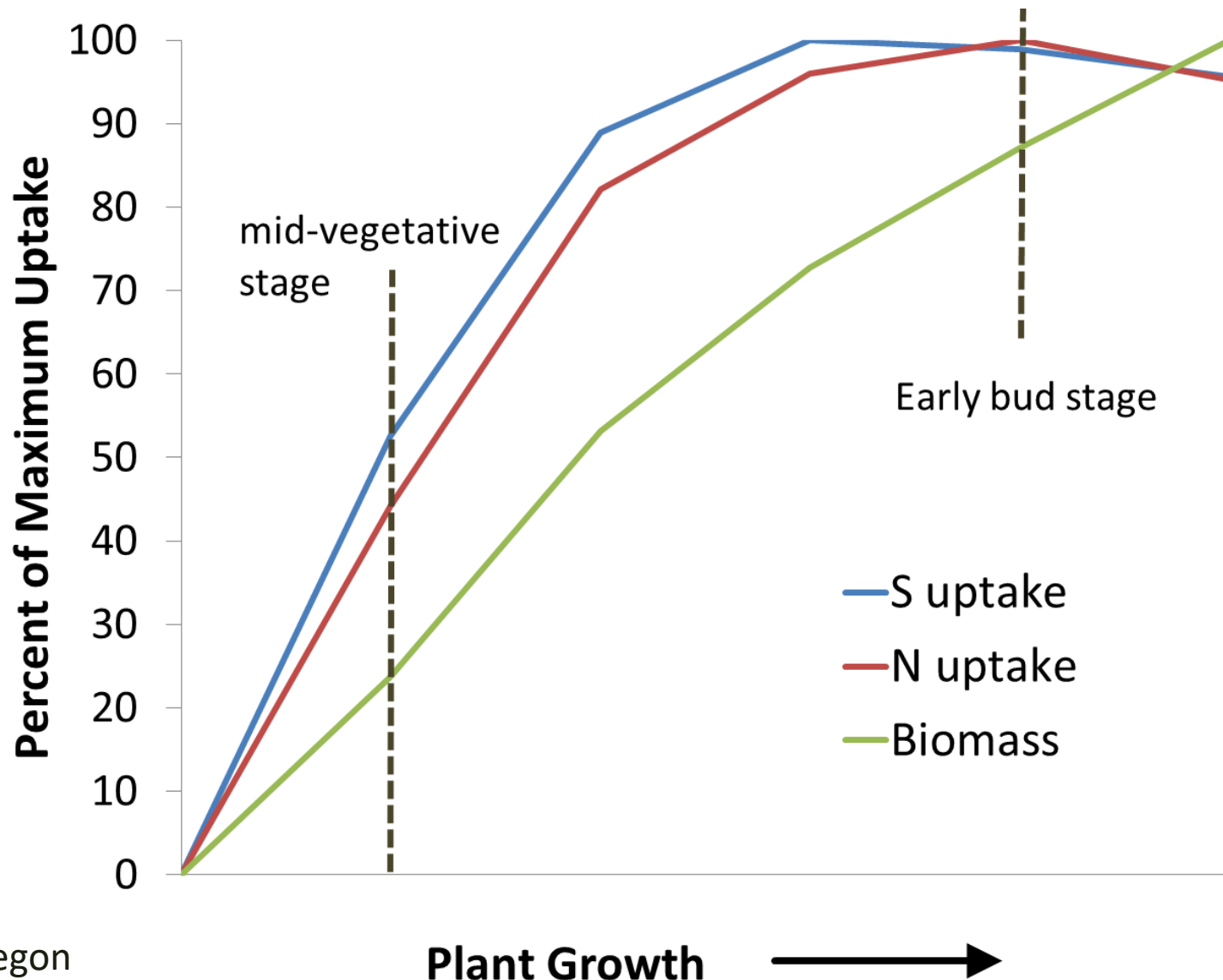


S influence on forage quality

- N conversion to protein requires S
- Increased S can lead to increased protein (FertFact #27) and digestibility, and reduced nitrate concentration (Westcott unpub data)



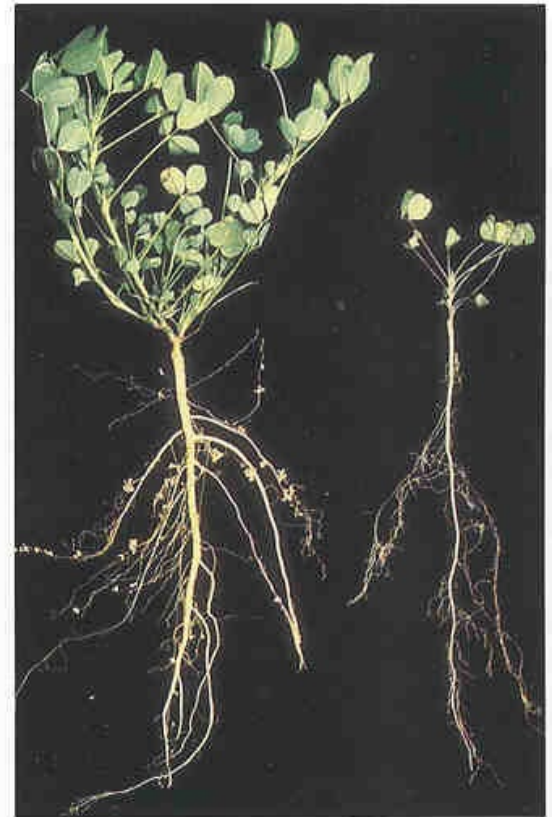
Provide S before mid-vegetative stage in alfalfa



Phosphorus (P)

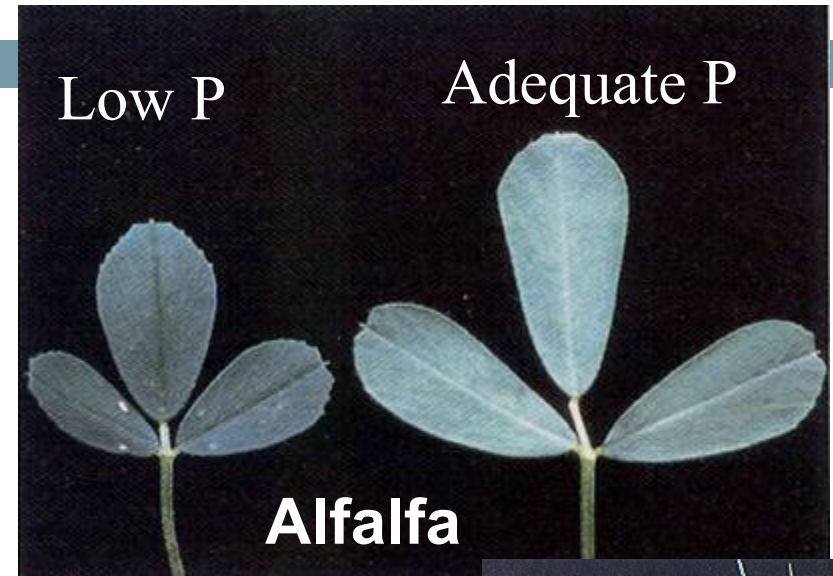
Why important to grass/alfalfa stands?

- Helps with N fixation in nodules
- Favors alfalfa over grass
- P improves alfalfa regrowth and recovery after cutting (IPNI)



P Deficiency Symptoms

1. Dark green, often purple
2. Lower leaves sometimes yellow
3. Upward tilting of leaves may occur in alfalfa
4. Often seen on ridges of fields



Corn



Barley, image
by IPNI



P guidelines for alfalfa and grass based on soil analysis

In Forages: P, K, S, & micros Soil Scoop and MSU EB0217

Crop	Olsen P Soil Test Level (ppm)				
	0	4	8	12	16
	P Fertilizer Rate (lb P ₂ O ₅ /acre)				
Alfalfa	140	110	75	40	20
Alfalfa/grass (50/50)	93	73	53	30	13
Grass	45	35	30	20	5
If soil test is above 16 ppm then consider using removal rate (10 to 11 lb P ₂ O ₅ /ton)					

Potassium (K)

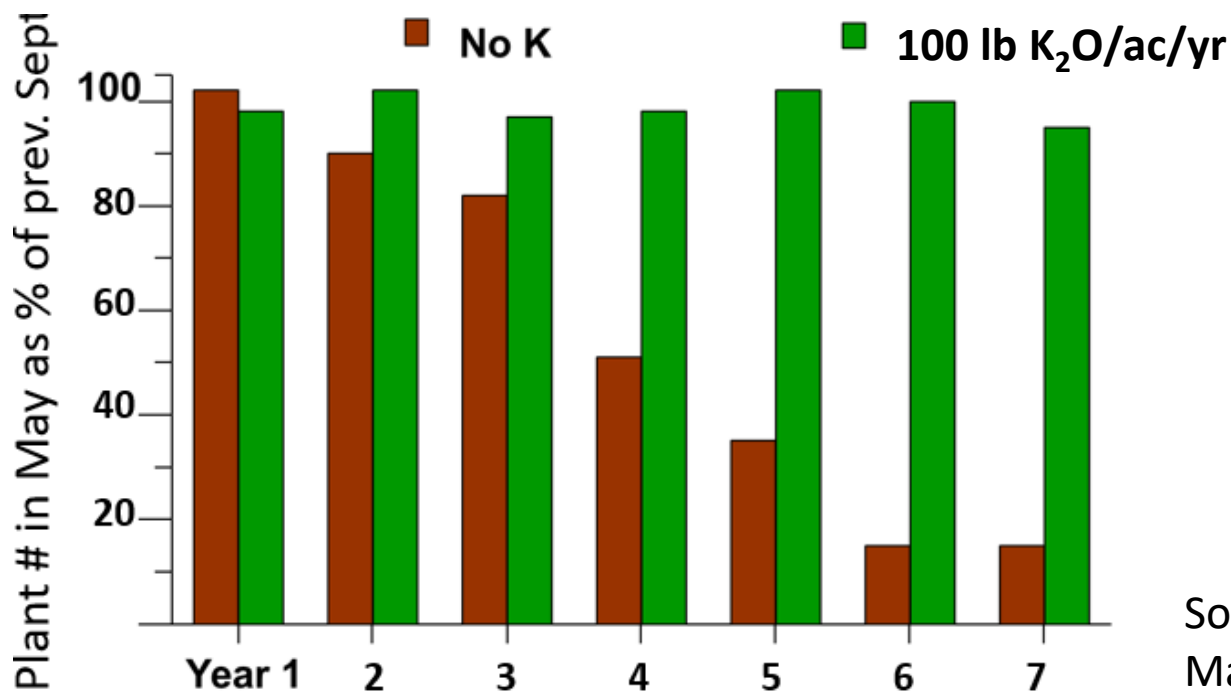
Benefits

- Improved alfalfa stand persistence, shoots per plant
- Reduces leaf drop of alfalfa
- Improved resistance to plant diseases
- Increased rhizobia activity = greater N fixation

Useful on many soils, even some having high K values (especially in cool spring soils)



How might lack of K affect an alfalfa-hay field?



K helps reduce
winterkill

Soil K 116 ppm (0-6")
Manitoba, IPNI

K deficiency symptoms

- Alfalfa – white spots on leaf edges
- Grasses and corn – chlorosis and necrosis on *lower* leaves first. WHY?
K is mobile in plant
- Weakening of straw-lodging in small grains, breakage in corn.



Wheat image
by IPNI

- Wilting, stunted, shortened internodes.

K guidelines for alfalfa and grass based on soil analysis

In *Forages: P, K, S, & micros* Soil Scoop and MSU EB0217

Crop	K Soil Test Level (ppm)					
	0	50	100	150	200	250
	K Fertilizer Rate (lb K ₂ O/acre)					
Alfalfa	240	205	170	140	95	30
Alfalfa/grass (50/50)	160	137	115	93	63	23
Grass	80	70	60	45	30	15

If soil test is above 250 ppm then consider using removal rate
38 lb K₂O/ton grass, 53 lb/ton alfalfa

To avoid toxic luxury consumption by first cutting, apply ½ the rate
after first cutting and rest after last cutting for following year

Questions?

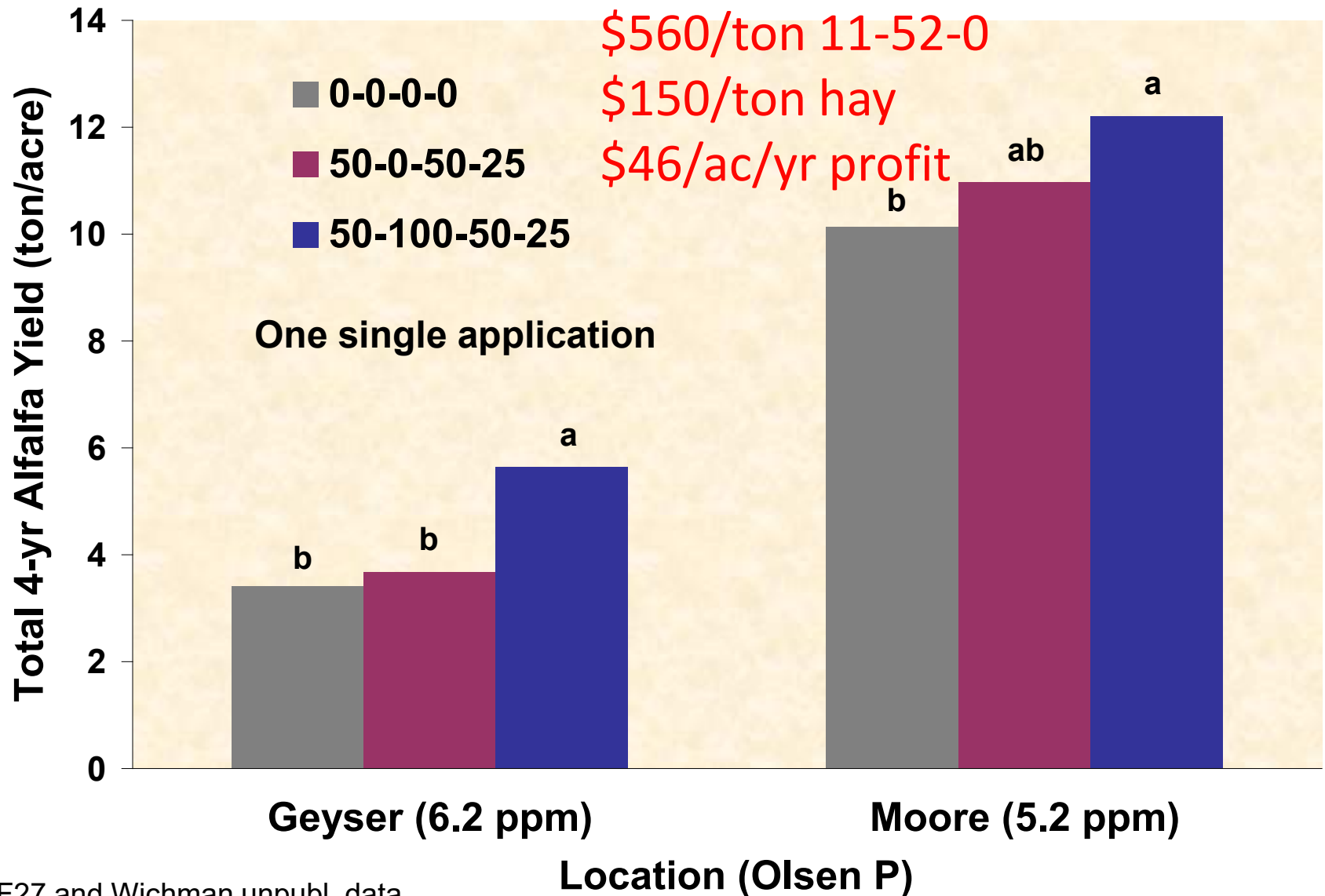


*On to forage response to
fertilization*

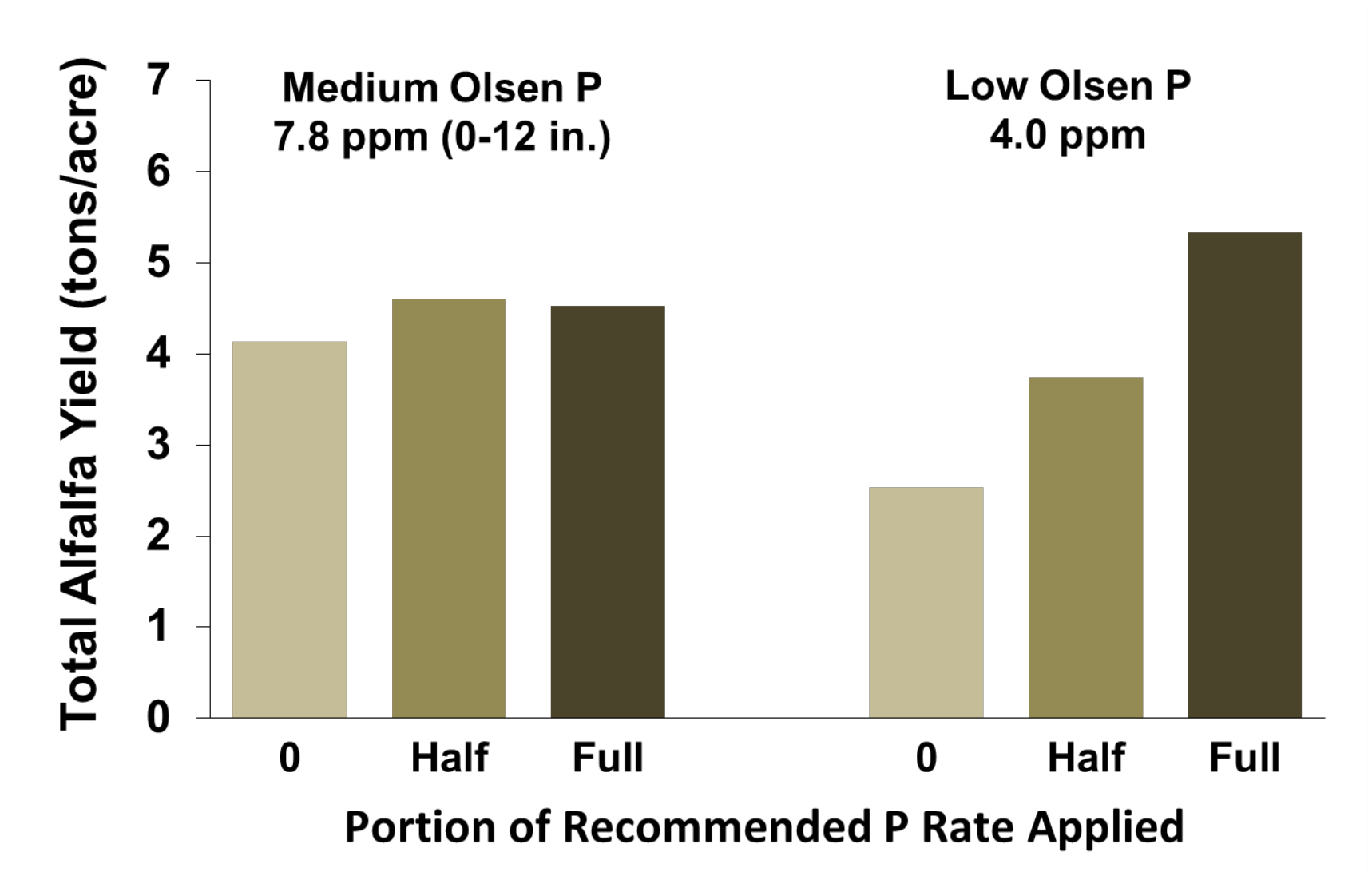
Fertilizing with P and K

- P and K can be 'banked' for several years
 - A single 100-400 lb P_2O_5 /ac on alfalfa = similar yield, protein, profit as same amount divided over 5 annual applications (Malhi et al. 2001).
 - 1 x 120 lb P_2O_5 /ac = 3 x 40 lb P_2O_5 /ac/yr avg bromegrass yield (Malhi et al. 1992, AB)
- Build up soil P and K levels prior to new seeding for several years worth
- Additional P and K seed placed can increase seedling establishment
 - < 10-15 lb (N + K_2O)/acre to reduce risk to seedlings
 - < 25 lb 11-52-0/acre with seed
- Too much K can lead to luxury consumption by crop and risk of milk fever

Single P application increased alfalfa-grass yield for 4 years (N, K, and S had minimal effect) in central MT



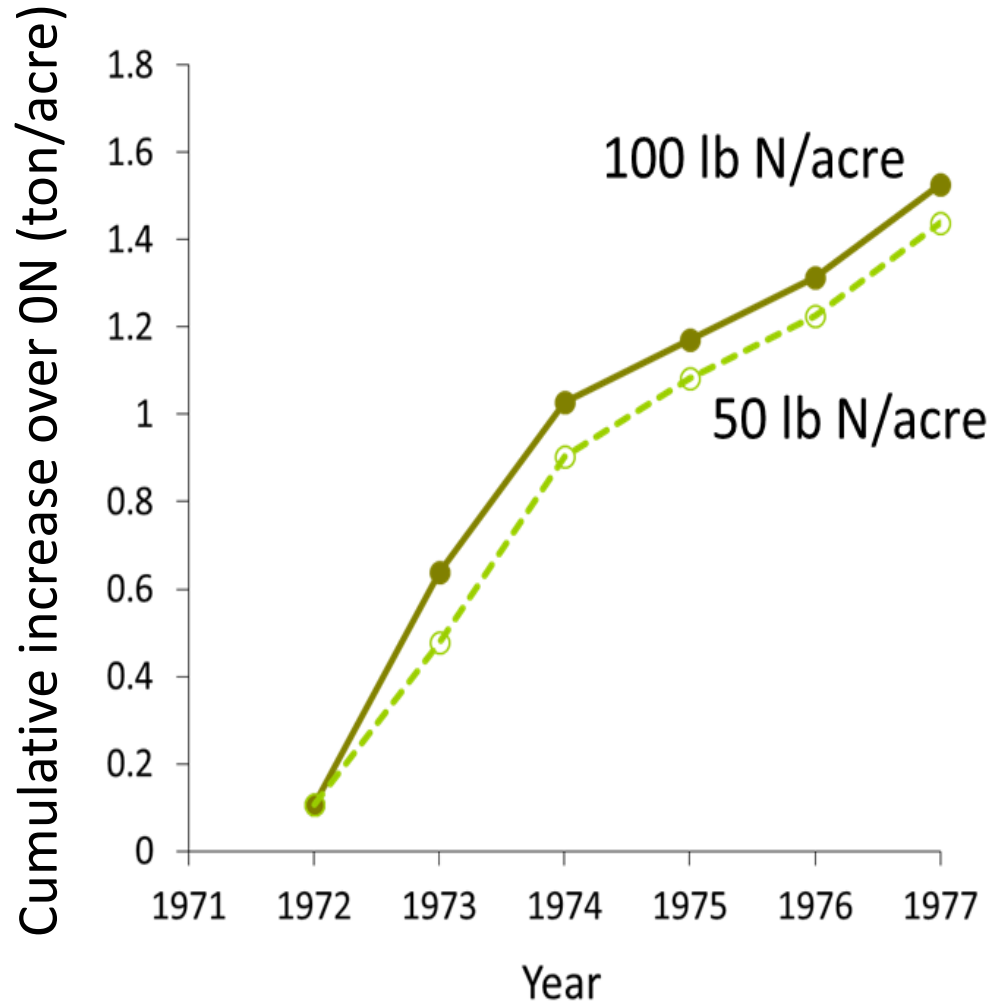
Response greater when soil level low



Irrigated alfalfa, broadcast MAP
Iron County, UT, Koenig et al. 2009

N fertilization of grass

- If a field < 75% legumes will be rotated to a different crop soon, consider N for immediate gain
- If need to buy hay or rent pasture, likely less costly to fertilize
- N can increase yields for many years (surprising to me!)
- A single 50 lb N/acre on dryland grass was more economical over 5-yr than a single 100 lb N/acre



Conclusions

- Nitrogen, phosphorus, potassium, and sulfur can all produce growth responses in forage
- Economic benefits often aren't realized in the first year (so don't base decisions on 1 yr studies!)
- Soil testing is essential for determining fertilizer needs

Download these Extension Bulletins



<http://landresources.montana.edu/soilfertility/publications.html>

<http://landresources.montana.edu/soilfertility/soilscoop.html>

Thank you! Questions?

Future sessions

Feb 10: Sustainable Nutrient Mgt

Feb 17: Cover crops



**This presentation and more information on soil fertility is
available at <http://landresources.montana.edu/soilfertility>**