Soil/Nutrient Basics and Fertilization of Hay and Pasture

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Goals

1. To better understand soil and nutrient variability, and nutrient deficiency symptoms
2. To understand fertilizer options (ammonium nitrate vs urea vs ammonium sulfate), and how timing and placement of fertilizer affect nutrient losses
3. To learn benefits of phosphorus, potassium, and sulfur on forages

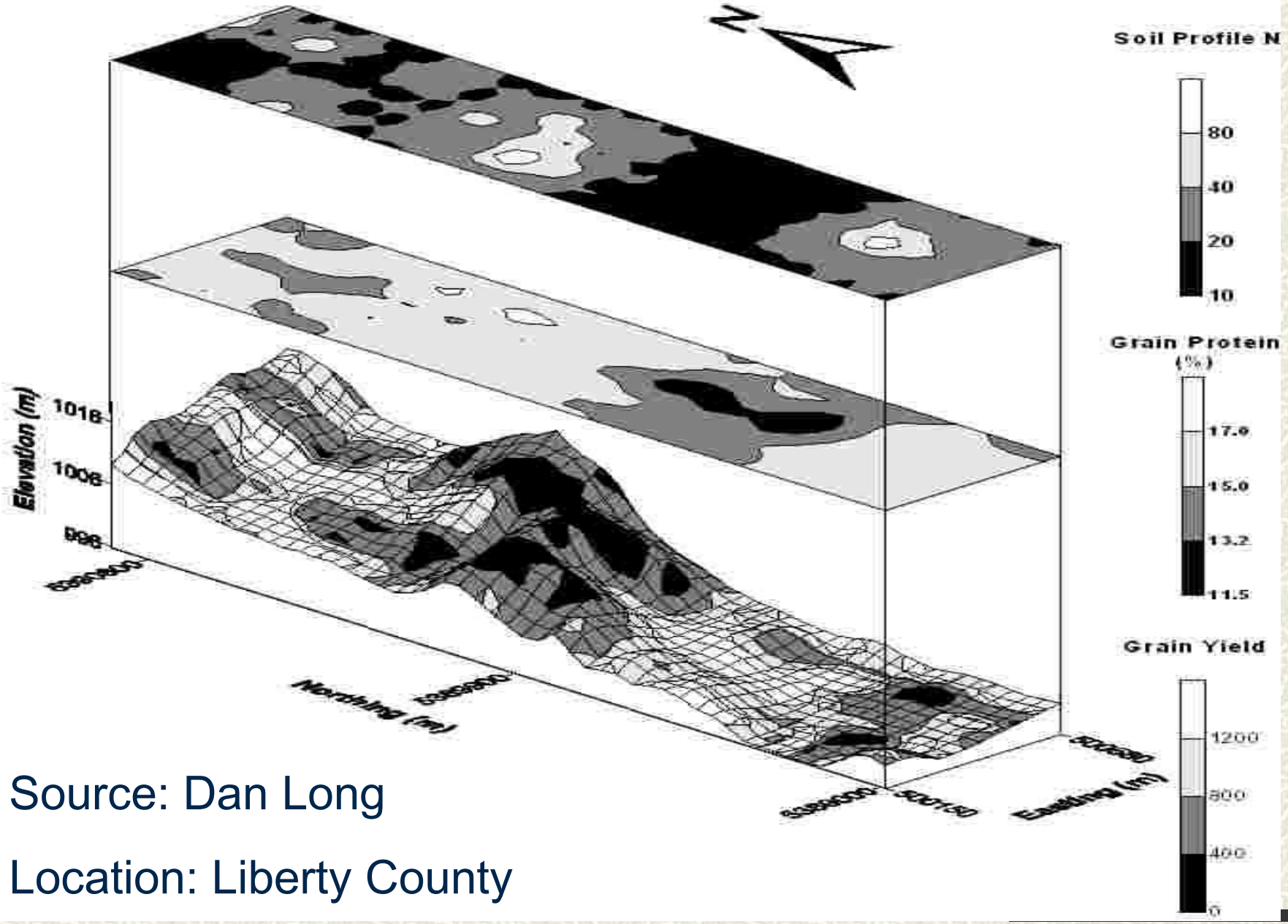
Some questions

How many of you raise alfalfa-hay?

How many grow grass for hay (w/o alfalfa)?

How many have pastures?

Who has tried annual forages (ex: Haybet barley)?



Source: Dan Long

Location: Liberty County

How could you get a feeling for soil variability in a field without mapping it yourself?

NRCS Soil Series Maps

Most are now digital and available on internet

http://maps2.nris.state.mt.us/mapper/PLSSSearch.asp

Enter township/range, then click on land information, then NRCS maps. (data file large and more difficult to download than maps-can obtain maps/data at Extension offices).

Most have not been verified but are based on topographic and vegetation similarities with known soil series.


839E
152E
56B
39C
988F
839D
580E
635B
152D
839E
534B
839D
W
179E
580E
513B
49C
42E
988F
1
2
152D
839E
735B
342C
752E
179F
839E
424C
534B
179E
580E
Fred
152E
152E
580F
179D
179F
488E
152C
Burr
135B
995F
242E
179E
179D
179E
580D
179F
179D
342E
179D
152E
135B
Creek
12

Information available in Soil Surveys that relates to soil fertility

- Soil depth-relates directly to Plant Available Water which affects yield potential
- Texture and water holding capacity (available water)
- pH-affects phosphorus (P) availability-lowest around pH 8, highest around pH 6.5
- Cation Exchange Capacity (ability to bind cations such as ammonium and potassium)
- Calcium carbonate – more P is needed when this number is above 0 in the upper layer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179D
179E
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Example soil data

	534B Gregson Silt Loam	513B Windlass-Nirling
Soil Depth	More than 60 in.	More than 60 in.
Texture	Silt loam	Loam-Cobbly loam
Avail. water	6.5 in.	2.6-3.6 in.
Soil pH	6.6-7.8	6.6-7.8
Cation Exch. Cap.	15-30	10-20
Calcium Carb.	---	0

Take home message

Soil Series maps can tell you about available water on your property and help you manage fields differently depending on soil properties.

QUESTIONS?

How might basic soil properties (Cation Exchange Capacity, pH, texture…) affect nutrient availability?

CEC?

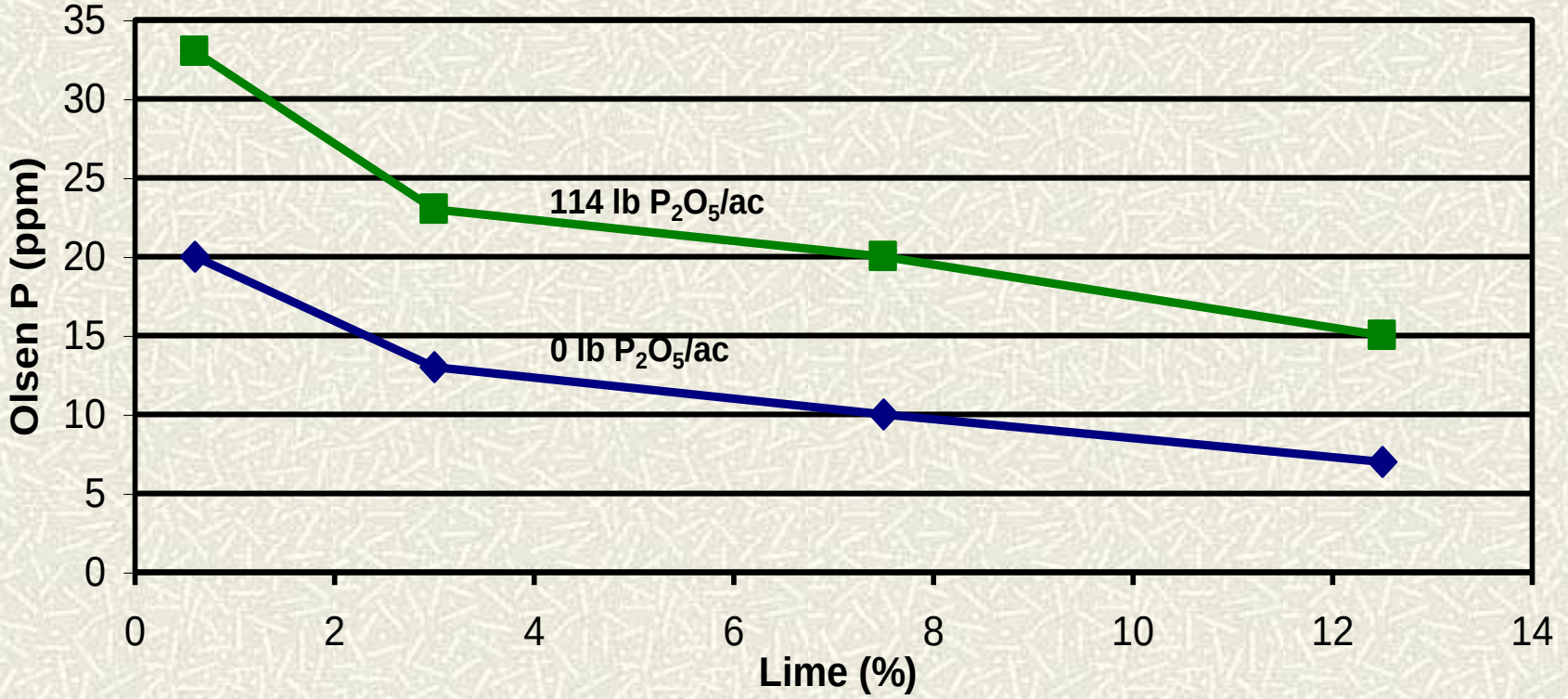
Texture?

Soil pH? P availability is highest around 6.5, lowest near 8.5

$CaCO_3$ content?

Effect of soil lime content on Olsen P soil test level

What is 'critical level' for Olsen P in Montana? 16 ppm



Adapted from Westermann (1992)

There are 14 mineral nutrients that have been found to be essential for growth of most plants:

Macronutrients	Micronutrients
Nitrogen (N)	Copper (Cu)
Phosphorus (P)	Iron (Fe)
Potassium (K)	Nickel (Ni)
Calcium (Ca)	Manganese (Mn)
Magnesium (Mg)	Zinc (Zn)
Sulfur (S)	Boron (B)
	Chloride (Cl)
	Molybdenum (Mo)

The macronutrients are simply needed in larger amounts by the plant than the micronutrients. I'll focus on N, P, K, and S.

Nitrogen (N)

Major Forms in Soil?

Plant available

Nitrate (very soluble/mobile)

Ammonium (binds weakly to clay)

Plant unavailable

Organic N (slowly supplies available ammonium to soil solution)

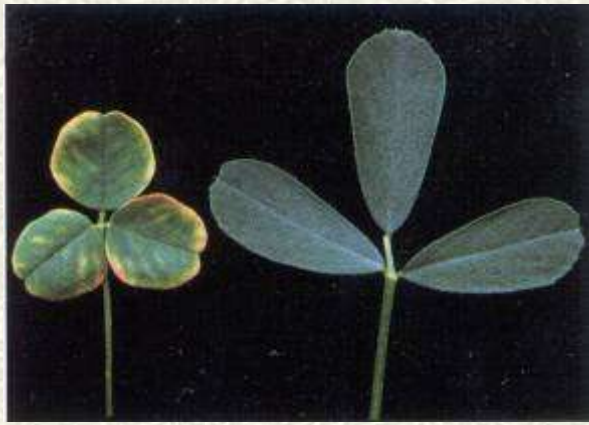
Factors decreasing N availability

1. Low organic matter
2. Poor nodulation of legumes (ex: alfalfa)
3. Excessive leaching
4. Cool temperatures, dry

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

Alfalfa



Corn

Tomato

How much N should be applied to alfalfa-grass stands?

Can use Fertilizer Guidelines for Montana Crops (EB 161)

ALFALFA/GRASS				
Yield Potential (t/a)*	80/20	60/40	40/60	20/80
	———N fertilizer (lbs/a)———			
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

Need to divide by fraction of N in fertilizer to find total fertilizer need

Why not use more nitrogen to boost yield?

- Favors grass, potentially decreasing protein and requiring more frequent alfalfa reseeding.

N fertilizers

Ammonium Nitrate (34-0-0)- Sometimes a quicker response than other N fertilizers. Why?

Simplot will stop selling within next year and some say it will not be available within 2 years. So what are options?

Urea (46-0-0)- apply on cool, thawed ground, on calm day. Irrigate in with at least 0.5 inches if can.

Ammonium sulfate (21-0-0-16)- minimal volatility problem, but more costly per unit of N. Could mix in a 50:50 blend with urea.

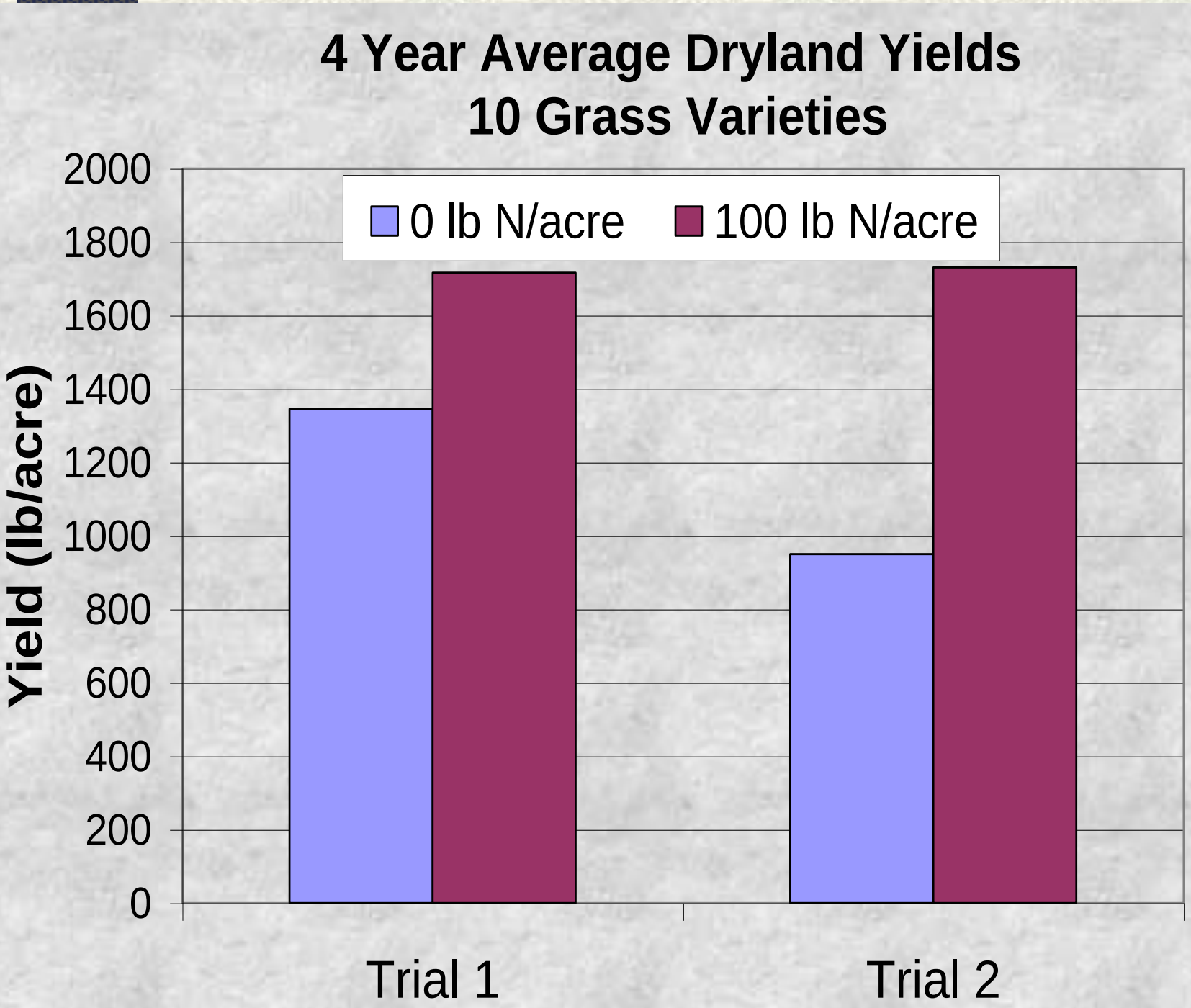
UAN – apply in bands to minimize volatilization

How much N should be applied to grass?

Fertilizer Guidelines for Montana Crops (EB 161):

GRASS	
Yield Potential (t/a) *	Available N (lbs/a) **
1	25
2	50
3	75
4	100
5	125

http://www.montana.edu/wwwpb/pubs/eb161.html


4 Year Average Dryland Yields
10 Grass Varieties
Yield (lb/acre)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0 lb N/acre
100 lb N/acre
Trial 1
Trial 2

Phosphorus (P)

Why often deficient in Montana soils?

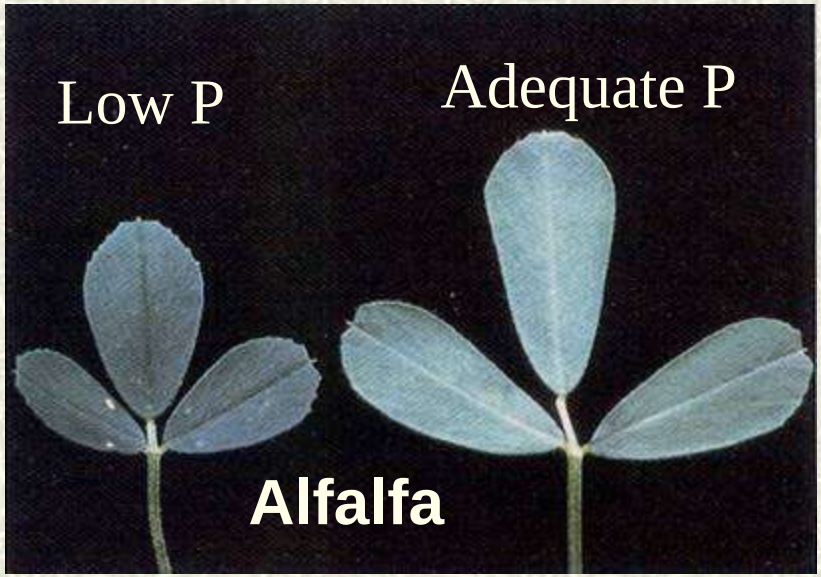
Binds with calcium to form poorly soluble calcium phosphate minerals

Factors decreasing P availability

1. Soil pH below 6.0 or above 7.5
2. Cold, wet weather
3. Calcareous soils
4. Leveled soils
5. Highly weathered, sandy soils

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

Advantages of phosphorus fertilization on alfalfa-grass stand?

- Helps with N fixation in nodules
- Favors alfalfa over grass

QUESTIONS?

Potassium (K)

Needed in Montana?

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

Which crops have largest K needs?

Table 1. K removal amounts in harvested portions of selected agricultural crops.

Crop	Assumed yield per acre	K_2O removal (lb/ac)
Alfalfa	2.5 t	150
Barley	50 bu	80
Brome	1.5 t	95
Corn silage	20 t	167
Orchard grass	1.5 t	75
Potatoes	300 cwt	330
Sugar beets	25 t	460
Timothy	1.5 t	94
Wheat	40 bu	80

From CFA (1995). Wheat and barley removal include head and straw.

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

Factors decreasing K availability

1. Cold, dry soils
2. Poorly aerated soils
3. High calcium and magnesium levels
4. Sandy, low clay soils
5. Low soil organic matter, or high amounts of available N

K deficiency symptoms

1. Alfalfa – white spots on leaf edges
2. Corn and grasses – chlorosis and necrosis on *lower* leaves first. WHY?

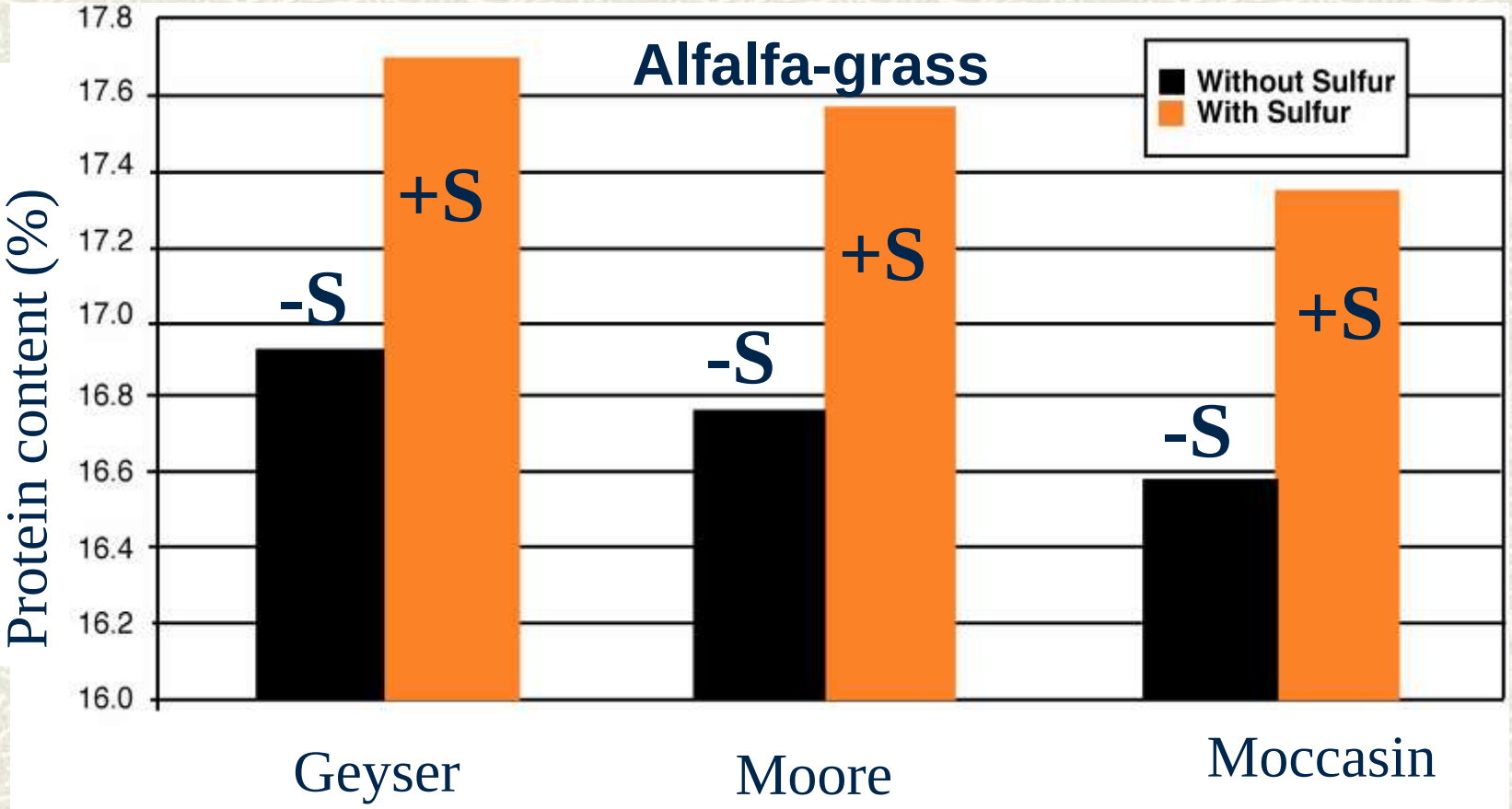
   K is mobile in plant
3. Weakening of straw- lodging in small grains, breakage in corn.

4. Wilting, stunted, shortened internodes.

QUESTIONS ON NITROGEN, PHOSPHORUS, OR POTASSIUM?

Sulfur (S)

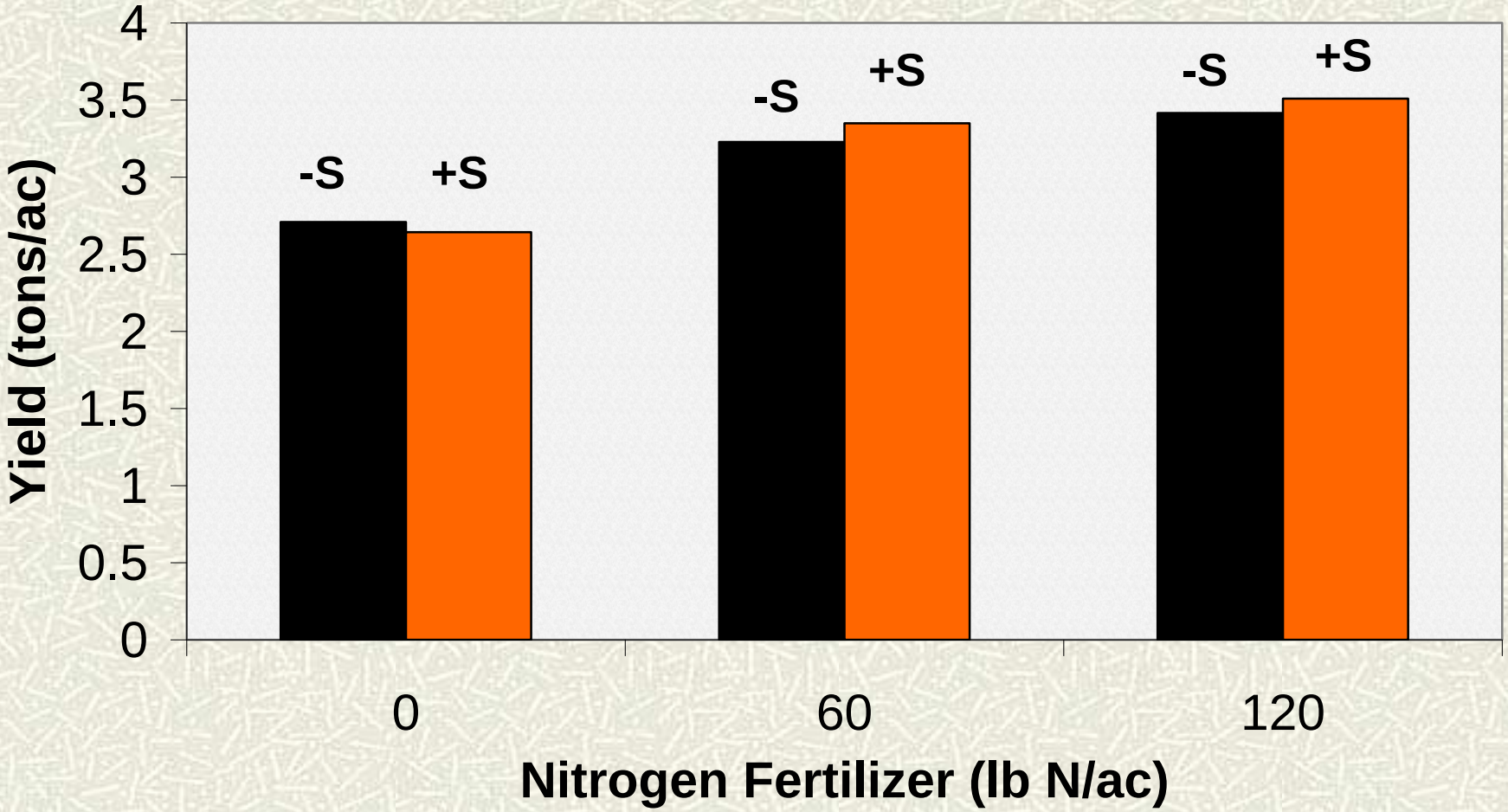
Responses seen in alfalfa-grass fields?



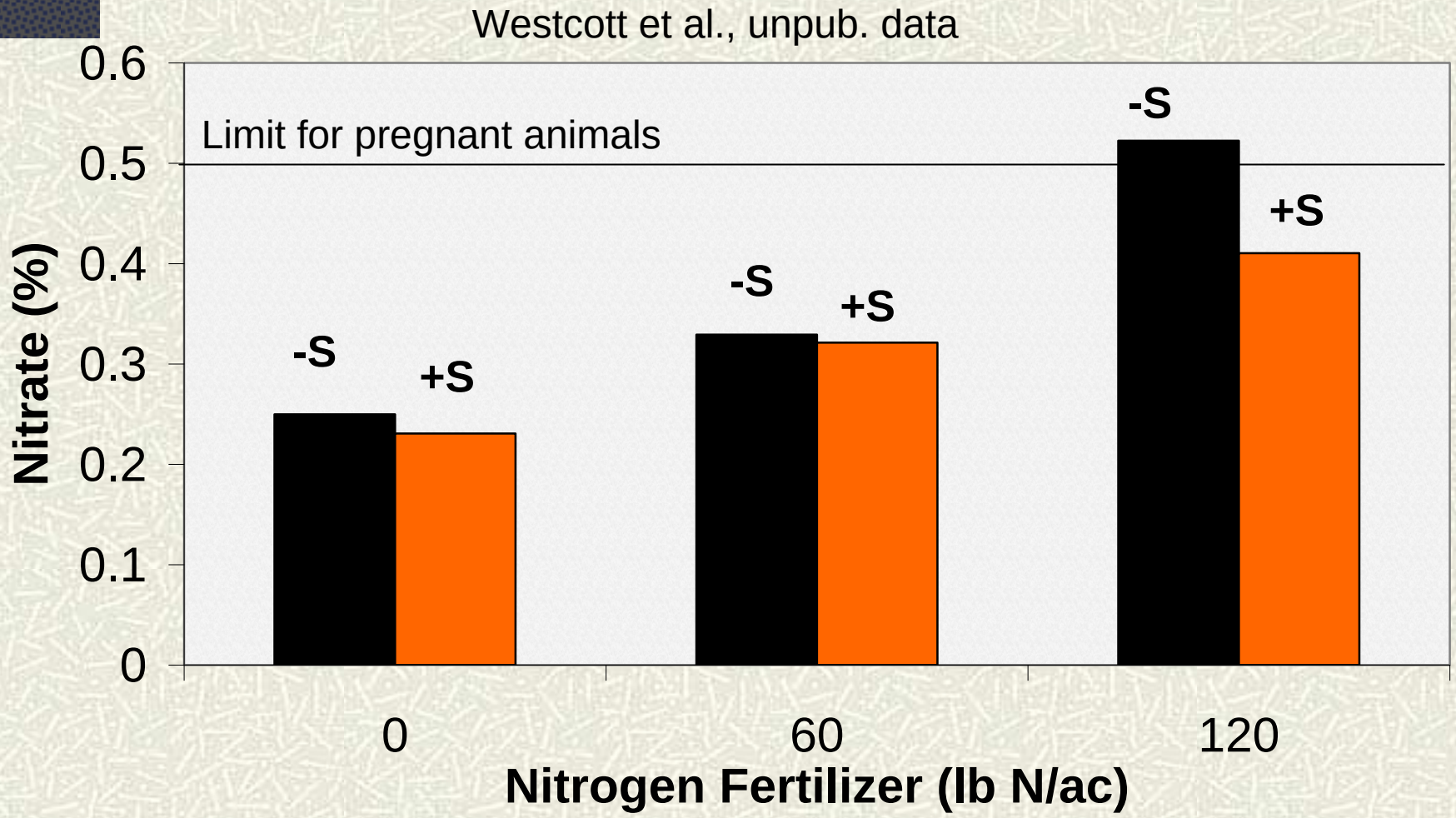
Note: Yield increased 30% at Moccasin (See Fert. Fact 27)

Effect of S on Haybet forage yield
Creston and Corvallis, 2002-2004

Westcott et al., unpub. data



Effect of S on Haybet Nitrate
Creston and Corvallis, 2002-2004



Factors decreasing S availability

1. Irrigated with low S in irrigation water
2. Sandy, acidic, or low organic matter soils
3. Cold soils
4. Soils formed from minerals low in S or far from industrial sources

S deficiency symptoms

1. Upper leaves light green to yellow. WHY?

   S is immobile in plant
2. Small, thin stems
3. Low protein
4. Delayed maturity
5. No characteristic spots or stripes

QUESTIONS ON SULFUR?

Beware Pseudo-deficiencies

What else can cause symptoms that look like nutrient deficiency symptoms?

1. Herbicides
2. Disease
3. Insects
4. Moisture stress
5. Salinity

Advantages of soil testing (even if only occasionally)

- Allows you to optimize fertilizer rates, especially in case where soil nutrient availability has been depleted or is in excess
- Can increase yield and/or save on fertilizer costs (which have gone up in last year)

CONCLUSIONS

- Optimizing fertilizer use is becoming more important with increased fertilizer costs
- Nitrogen, phosphorus, potassium, and sulfur can all produce growth responses in Montana forage.
- Recognizing nutrient deficiencies can help with fertilizer decisions
- Soil testing is useful for determining fertilizer needs

Questions/Input?

Additional info at
http://landresources.montana.edu/soilfertility