Minerals in Forages: Plant Considerations

J.B. Peters and K.A. Kelling

Soil Science Department

University of Wisconsin - Madison

Macro-minerals:

- Ca – component of cell walls, involved in cell division and elongation, cell membranes and N metabolism
- Mg – component of chlorophyll. Low Mg associated with hypomagnesemia (*grass tetany*)
- P – energy transfer in plants, component of the nucleus
- K – needed in large quantities in plants

Potassium function in forage legumes

- Enzyme activity
- Carbohydrate production and transport
- Stomatal activity
- Links to increased resistance to disease and lodging
- **Balances anionic charges**

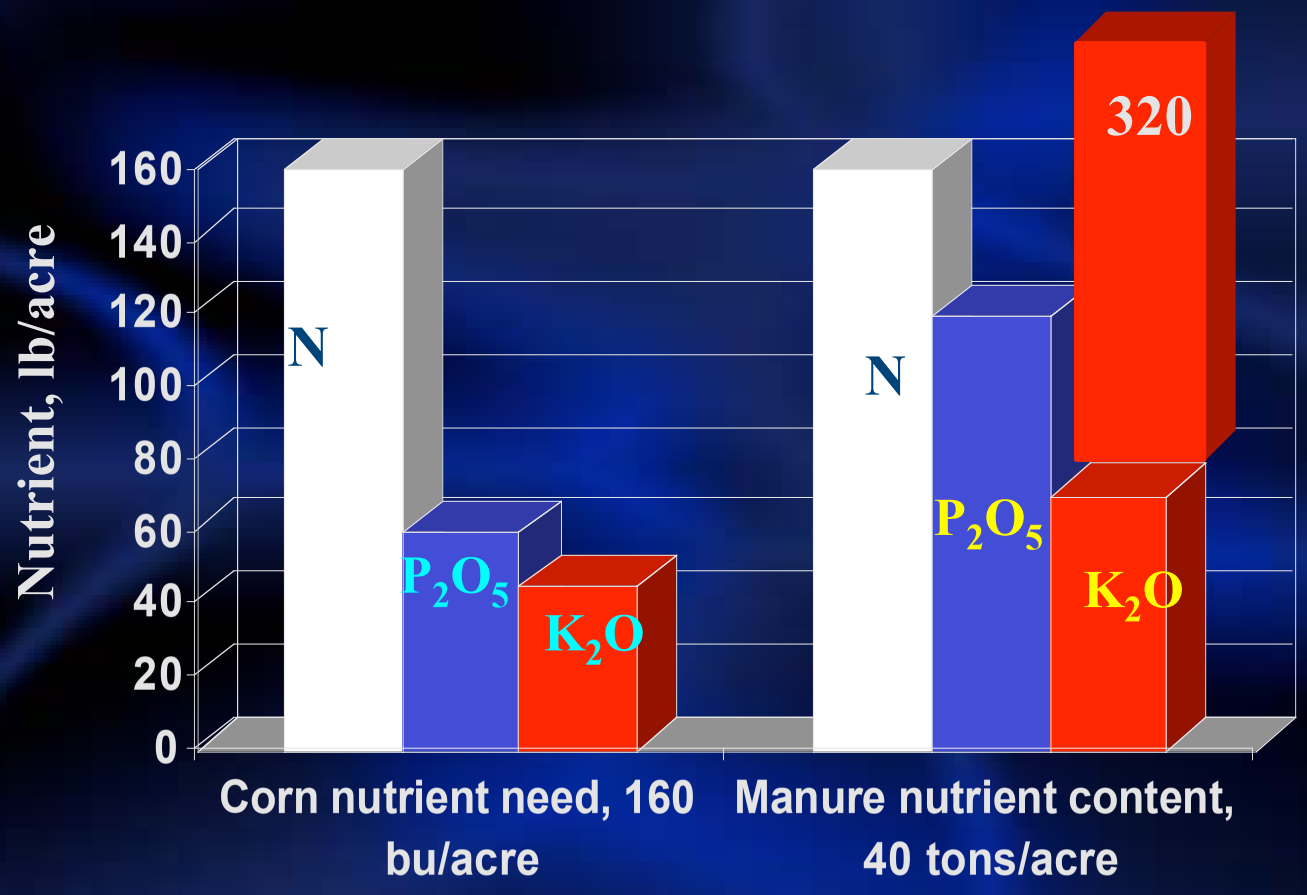
K in plants:

- Taken up as K^+
- 0.5-8% in plant tissue
- Concentrated in stems and top of plant
- Moves to root by mass flow and diffusion

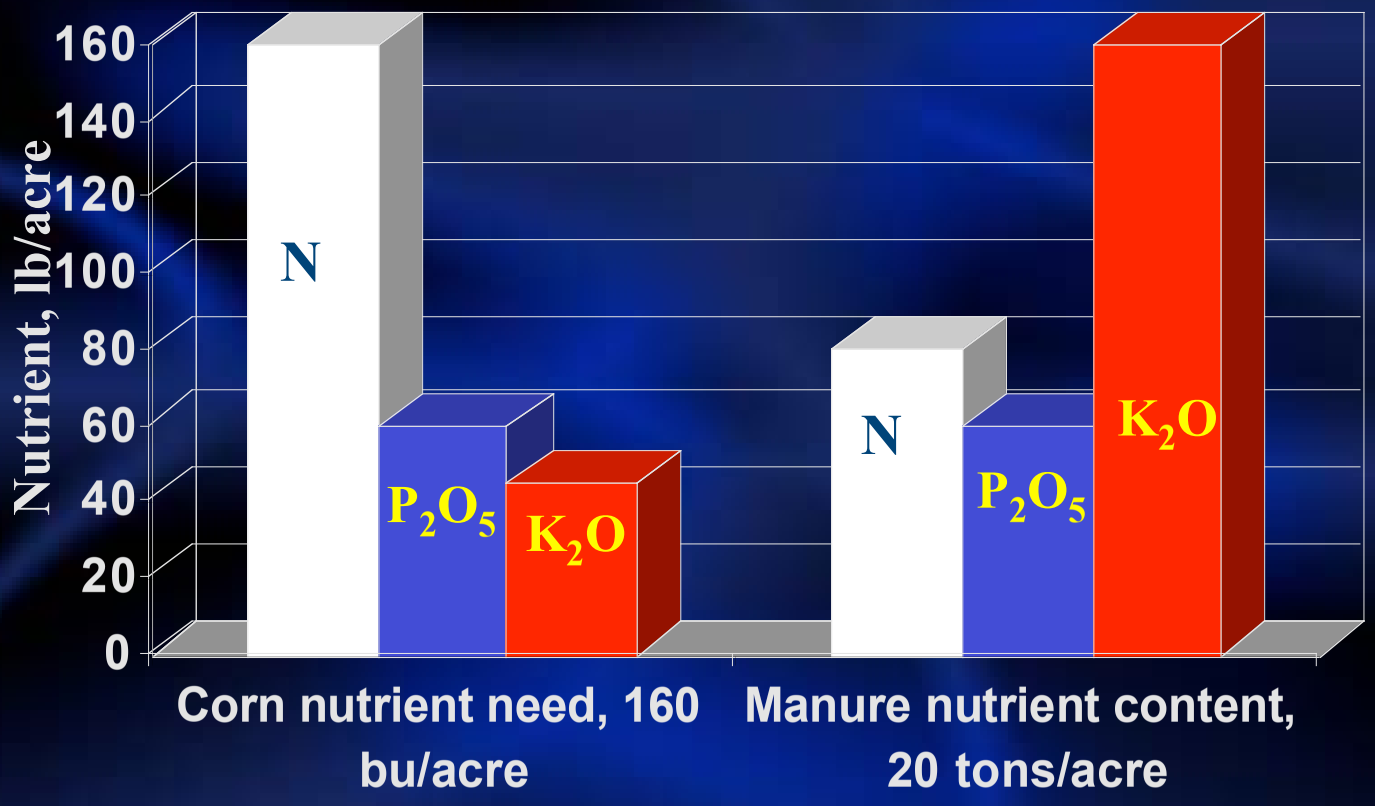
K management in Wisconsin

1. Soils can be low or deficient, especially if alfalfa is in the rotation, without significant manure applications
2. Topdress K is often used as insurance
3. Excessive K in some forages is common

Comparison of corn nutrient needs with manure nutrient content - Nitrogen strategy



Comparison of corn nutrient needs with manure nutrient content- Phosphorus strategy



Plot locations used for forage cation research, 1997-2001

- Marshfield – six pH levels 4.8 - 7.3
- Spooner – five pH levels 4.7 - 6.7
- Hancock – six pH levels 4.5 - 7.0

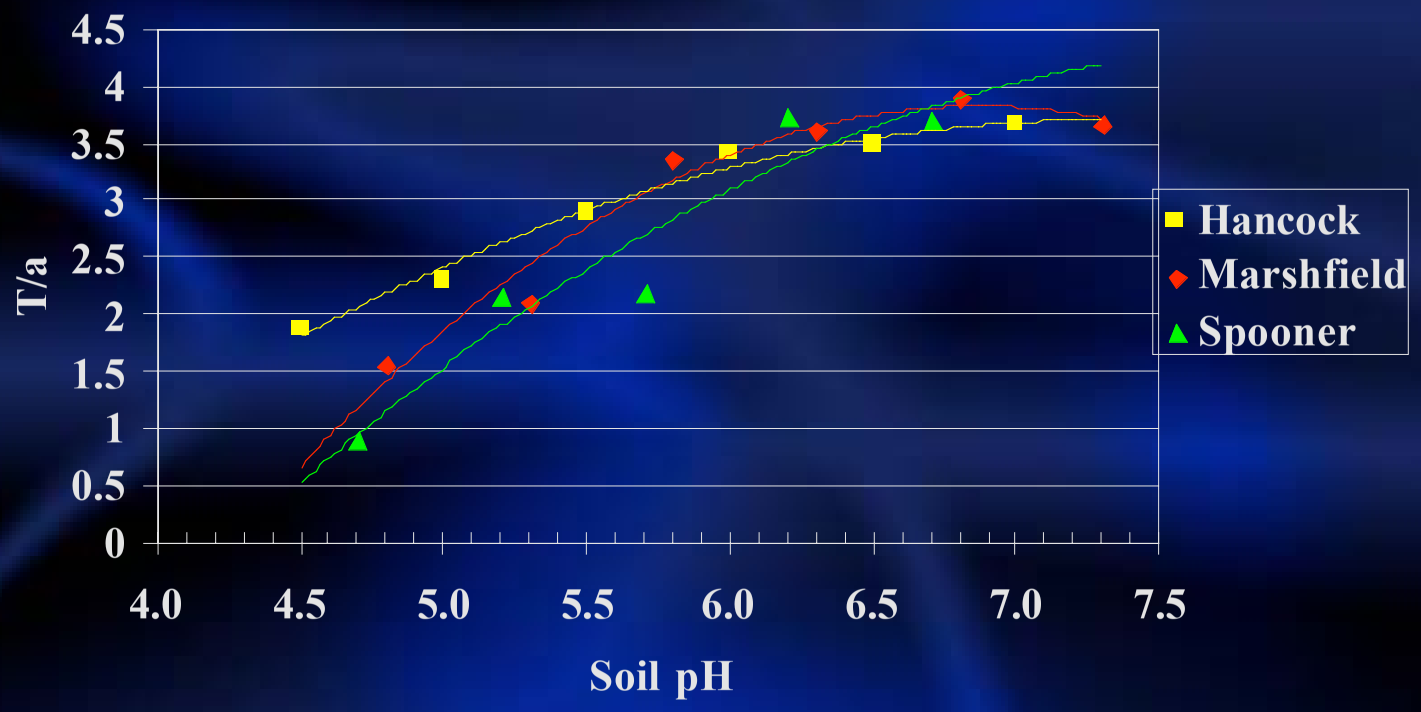
pH – 4.9

Picture taken in May following the seeding year

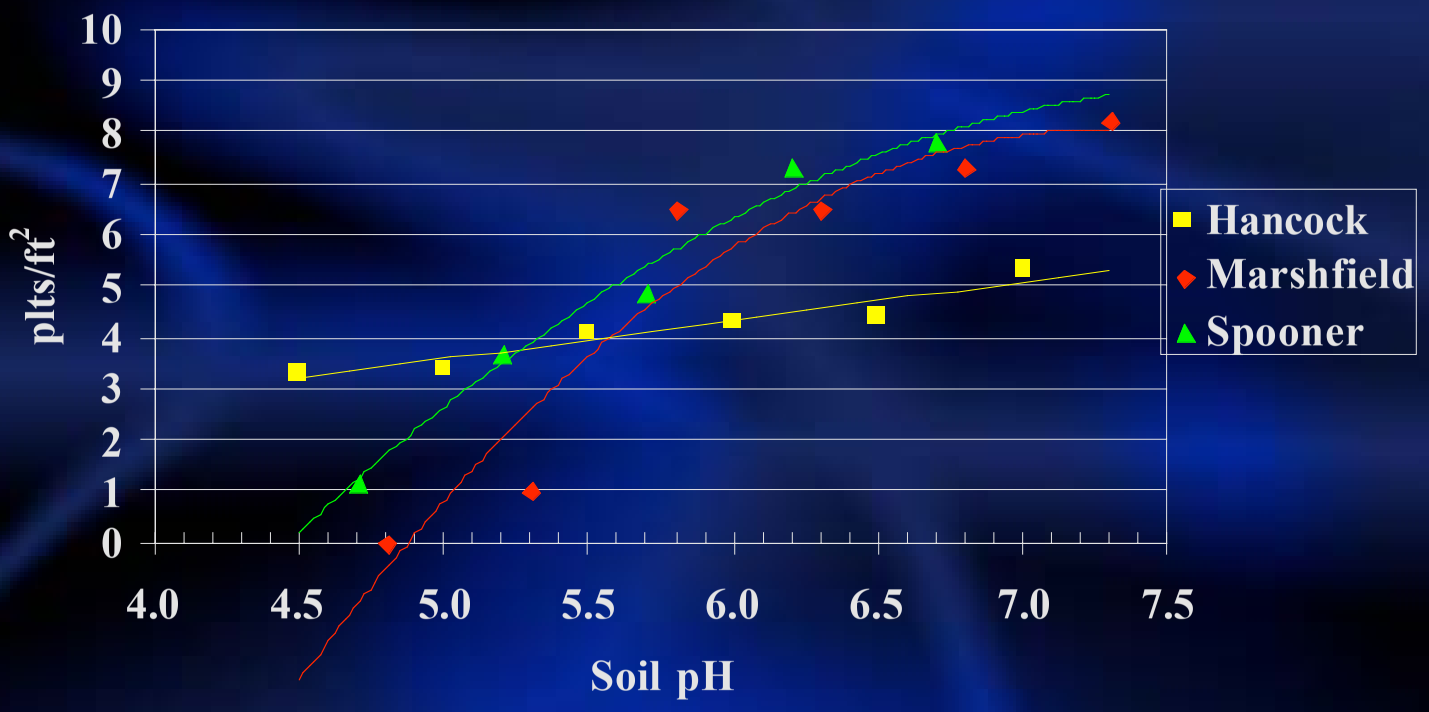
pH – 6.8

Picture taken in May following the seeding year

Average annual alfalfa dry matter yield by soil pH (1998-2001)



Final stand quality by soil pH (1998-2001)



K Treatments

- Four K_2O levels – 0, 100, 200, 400 lbs K_2O/a/year*

*Applied after first cutting

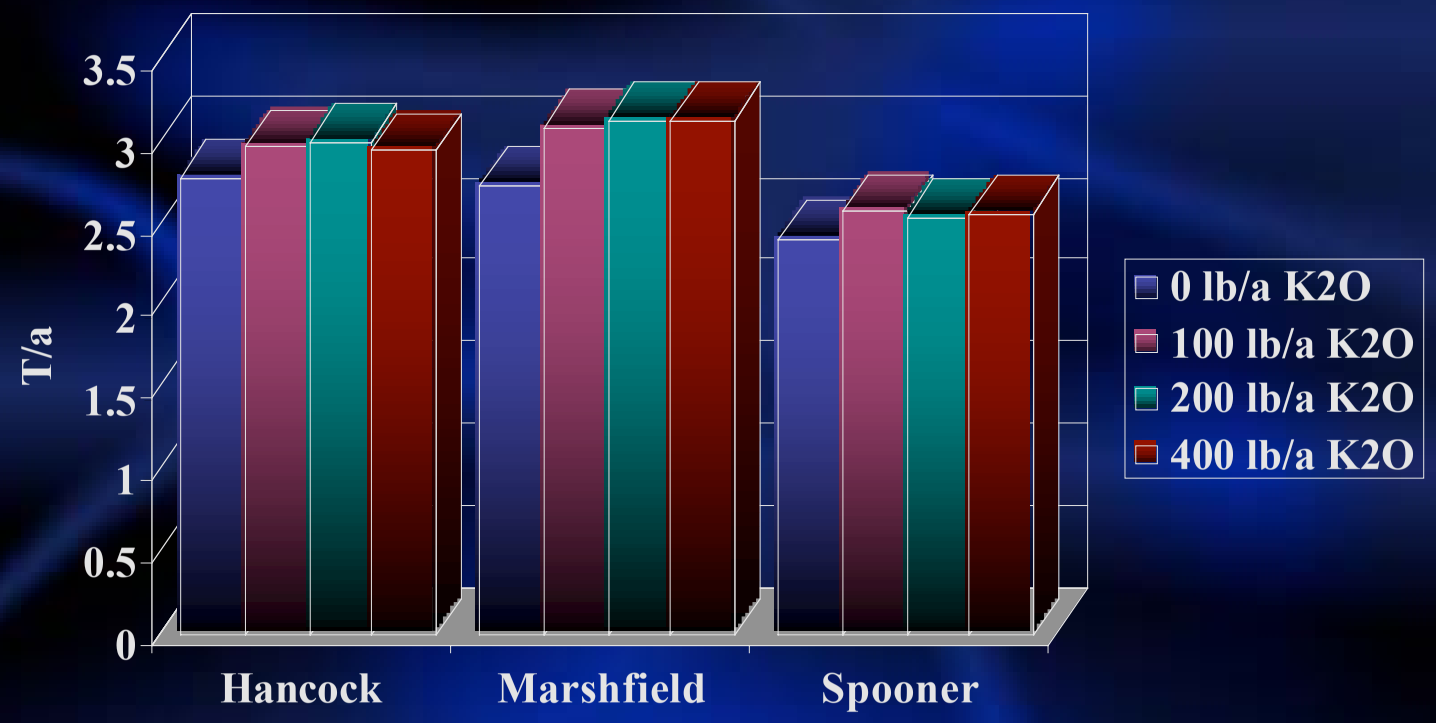
Alfalfa response to annual K applications at pH 7.0

3rd cut Marshfield, 2000

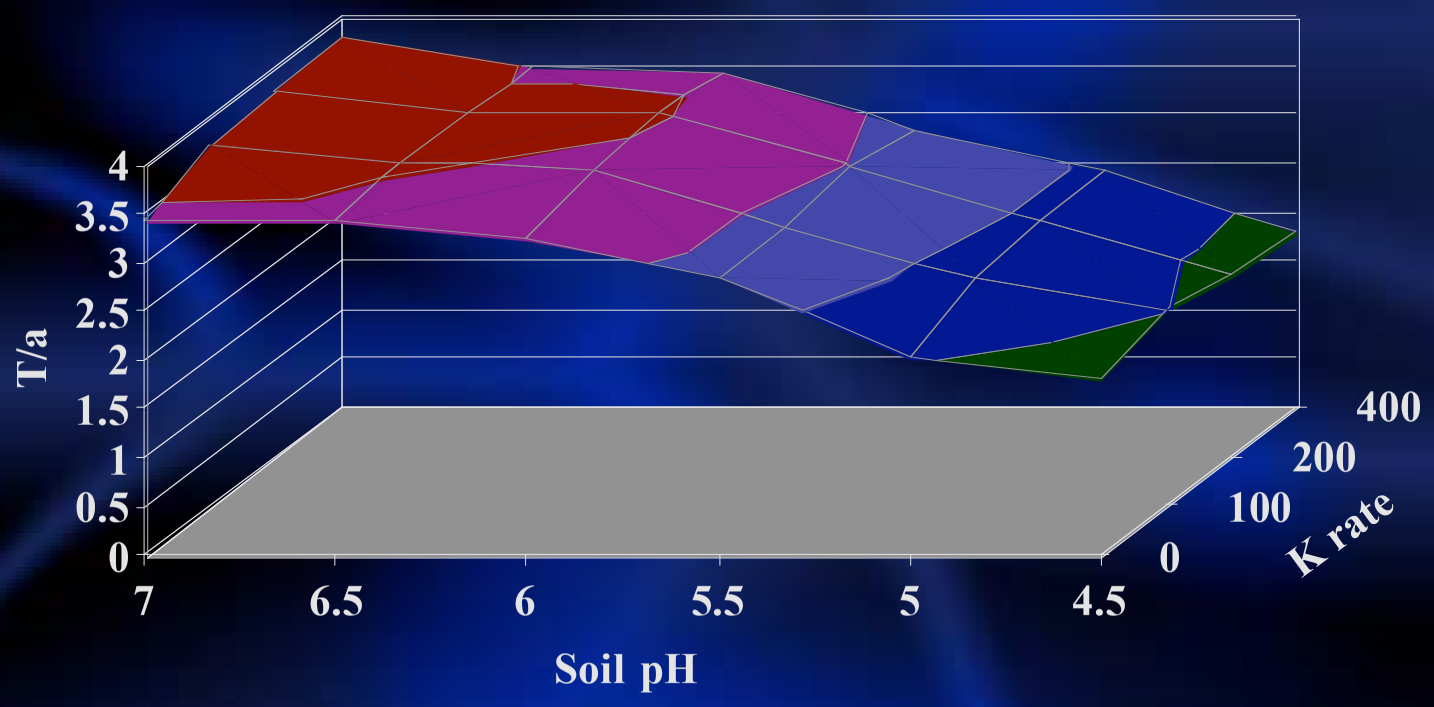
Alfalfa response to annual K applications at pH 6.4

3rd cut Marshfield, 2000

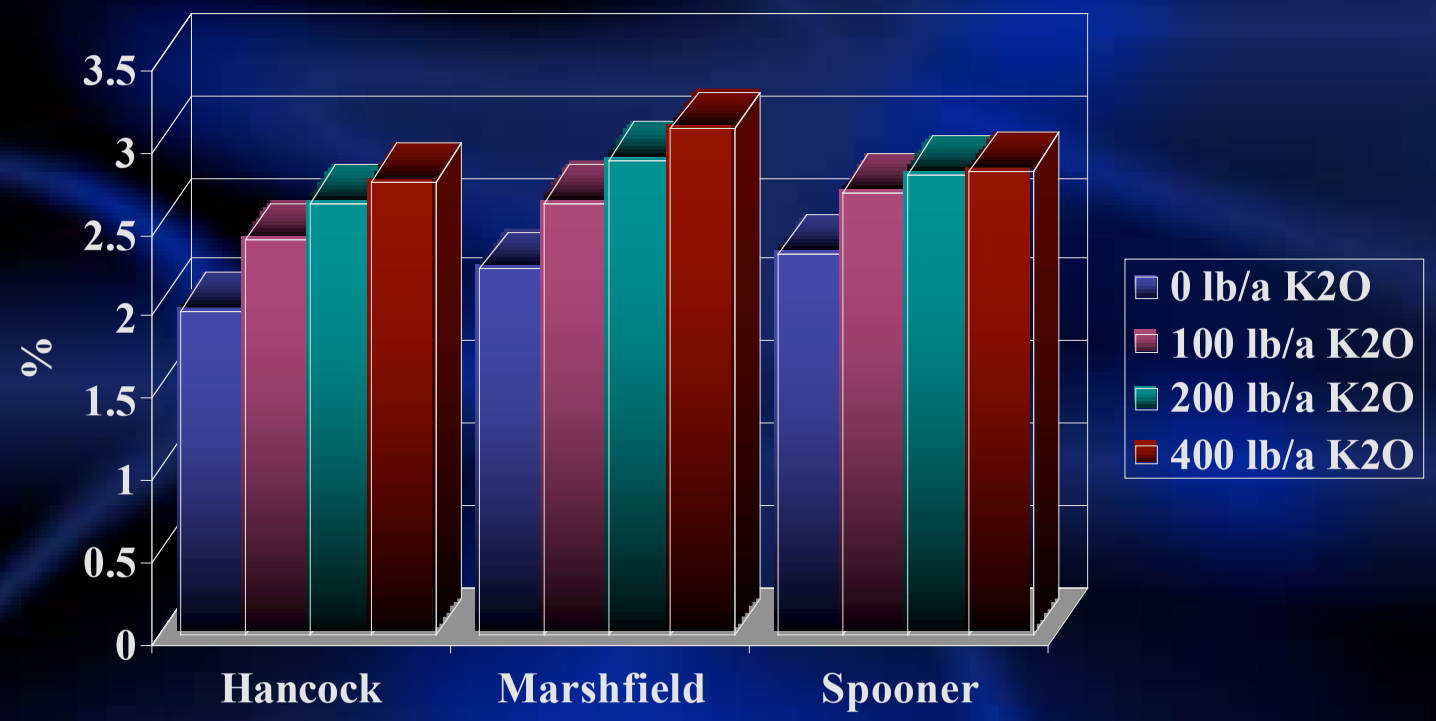
Annual alfalfa yield by K_2O rate (1998-2001)



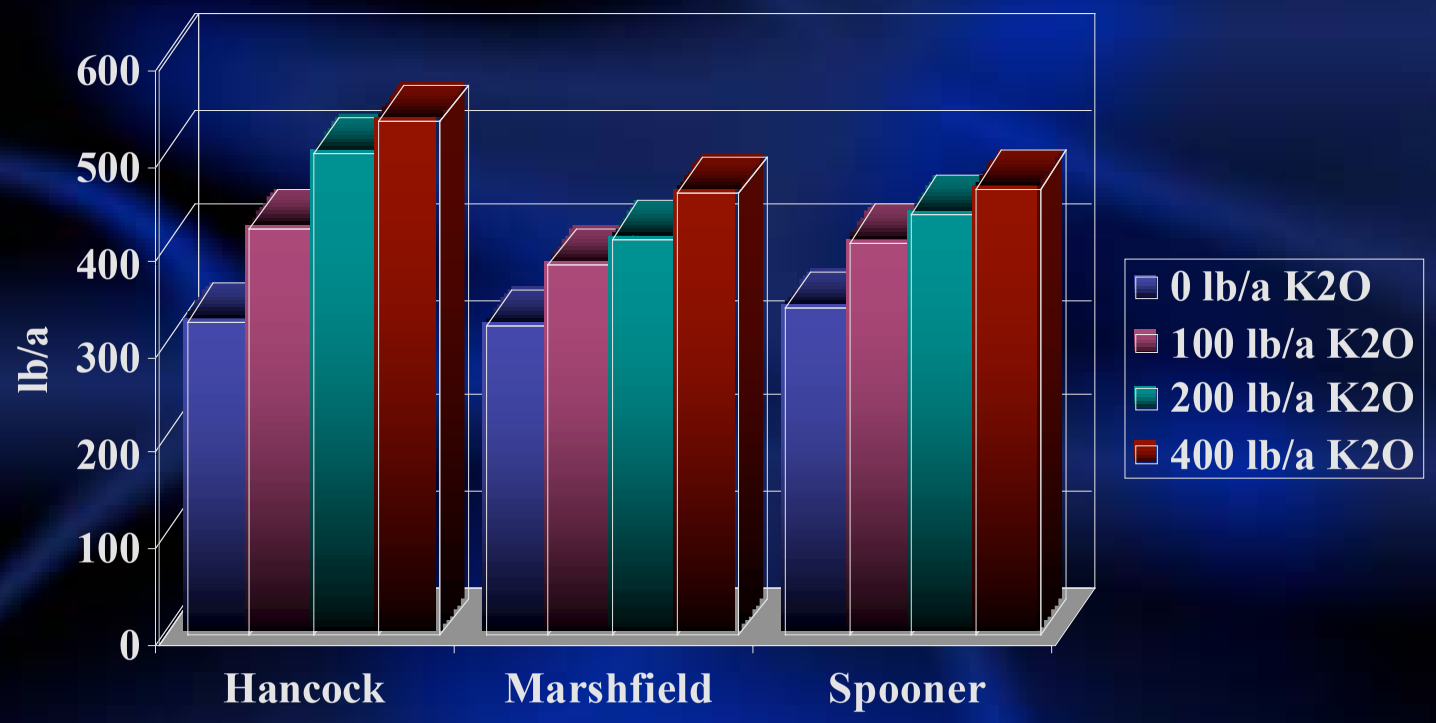
Effects of pH and K on alfalfa dry matter yield (Hancock, 1998-2001)



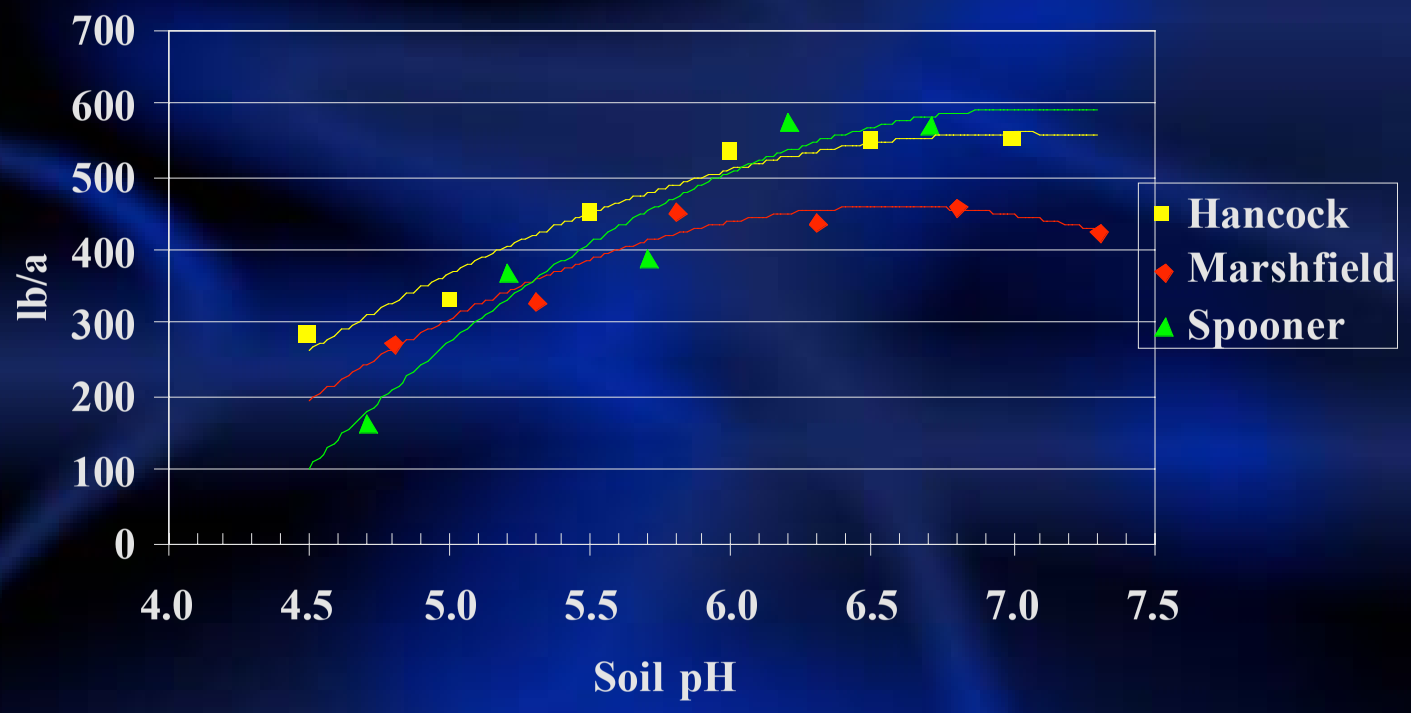
Alfalfa tissue K by K_2O rate (1998-2001)



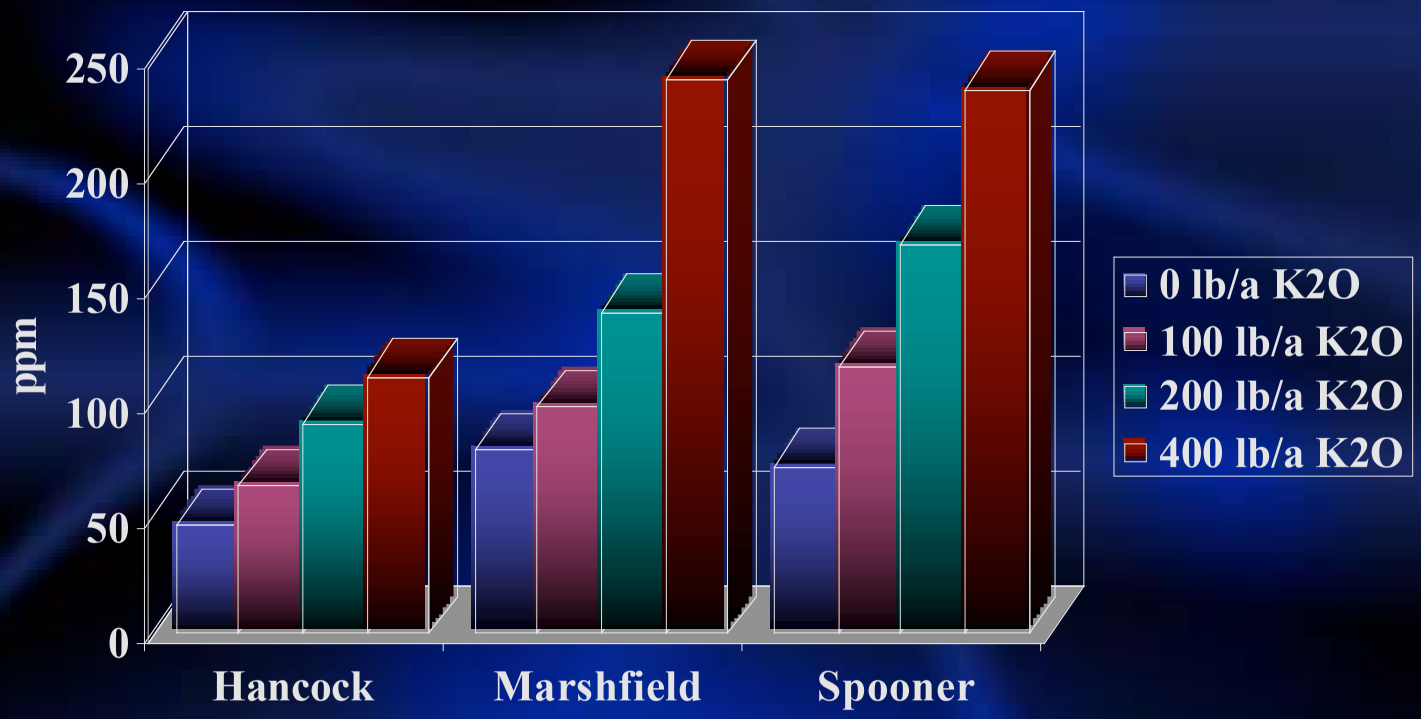
Total K removed in alfalfa tissue (1998-2001)



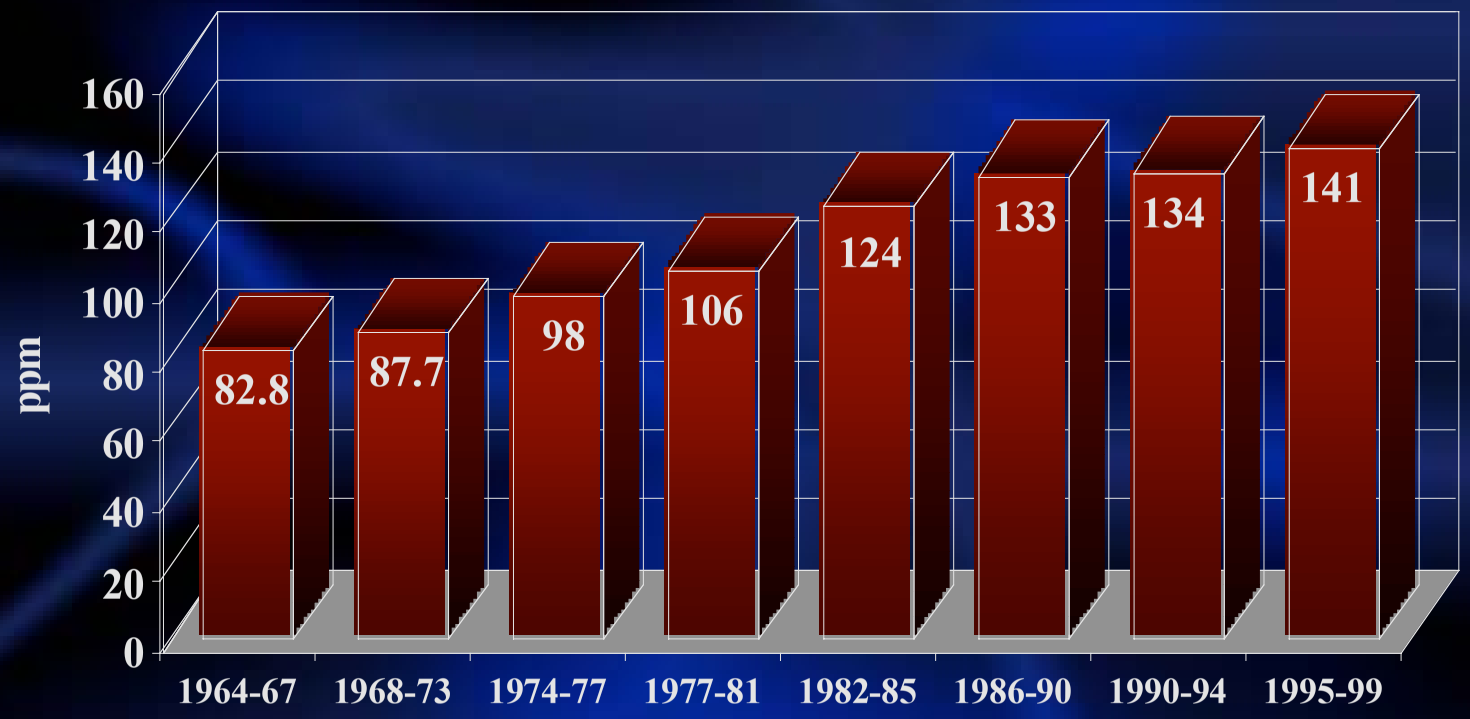
Total K removed in alfalfa tissue (1998-2001)



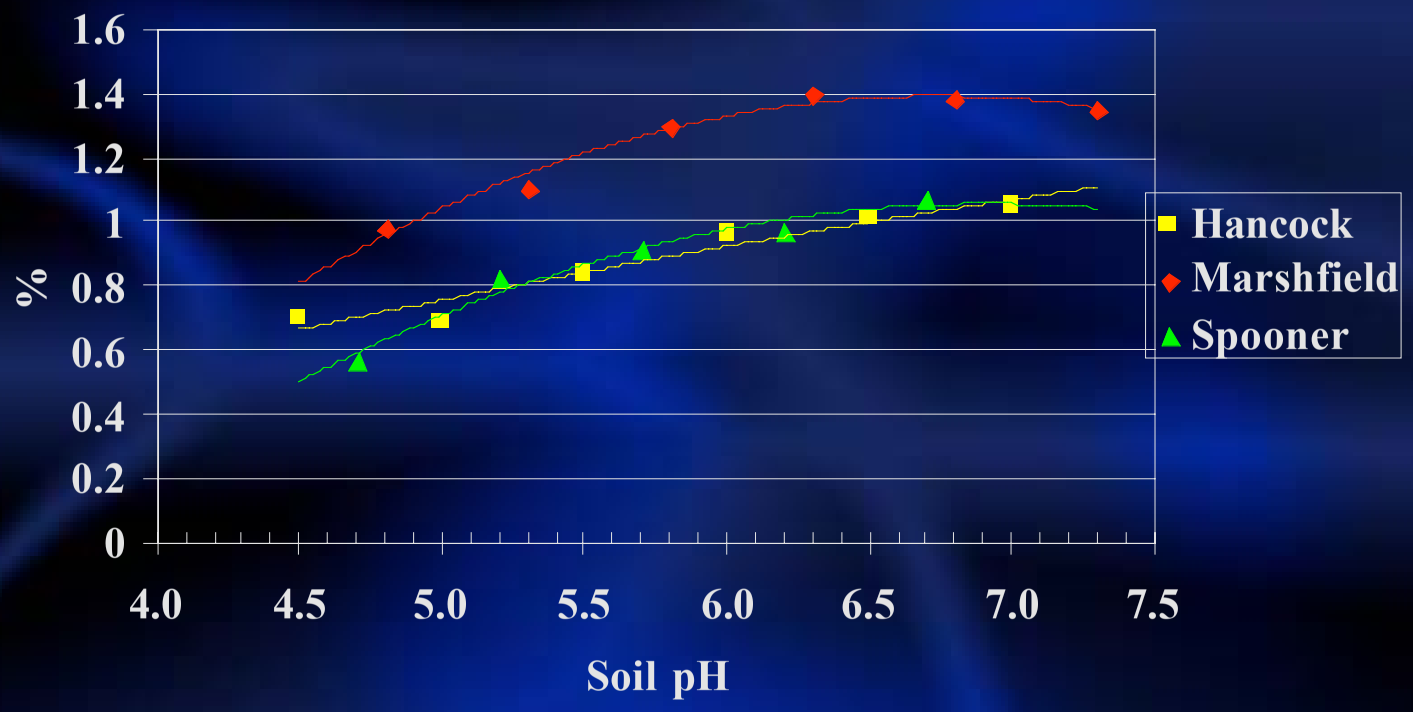
Final soil test K (1998-2001)



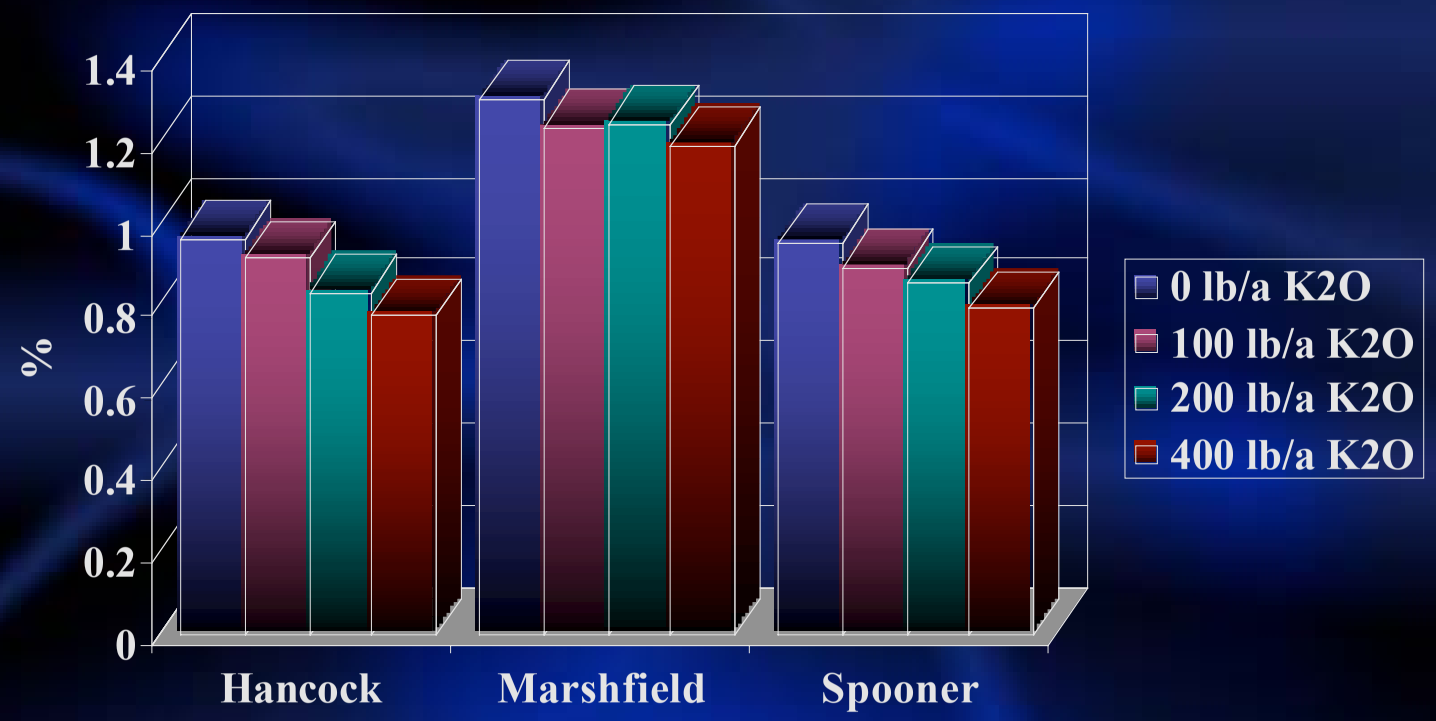
Wisconsin soil test K trends 1964-1999



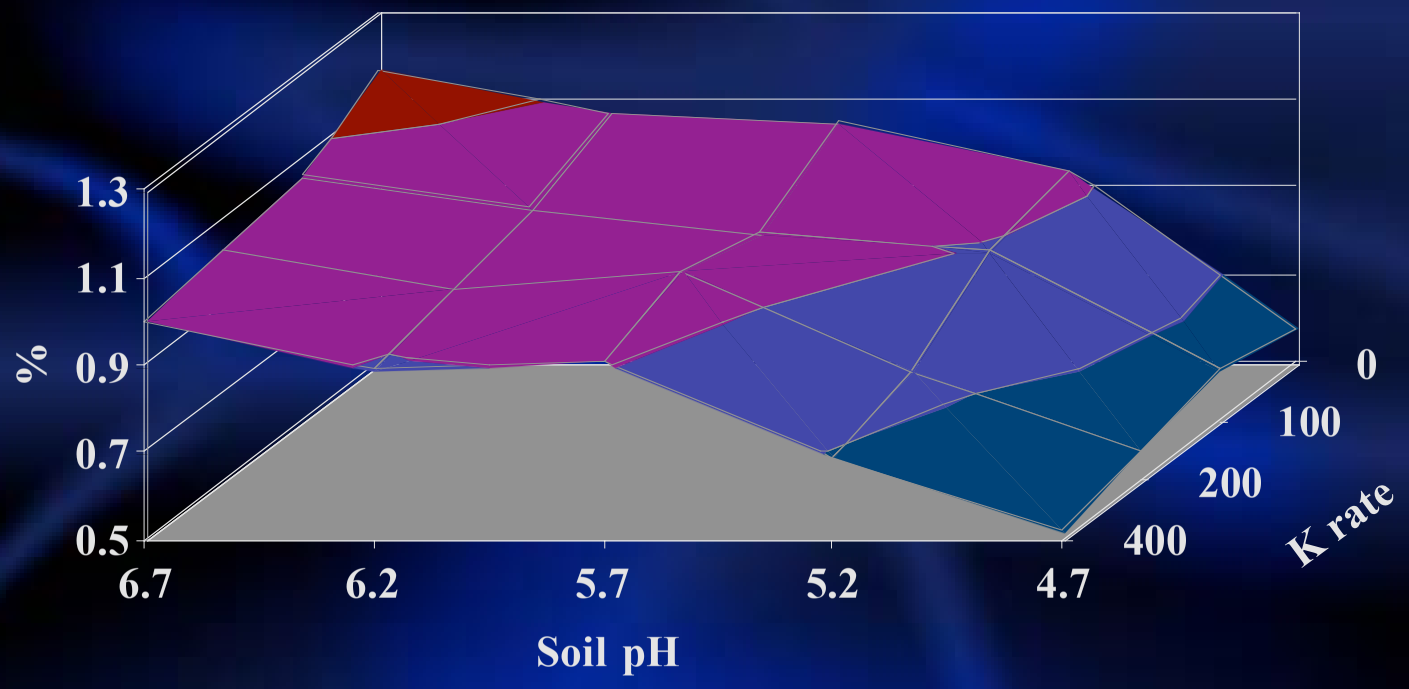
Alfalfa Ca level by soil pH (1998-2001)



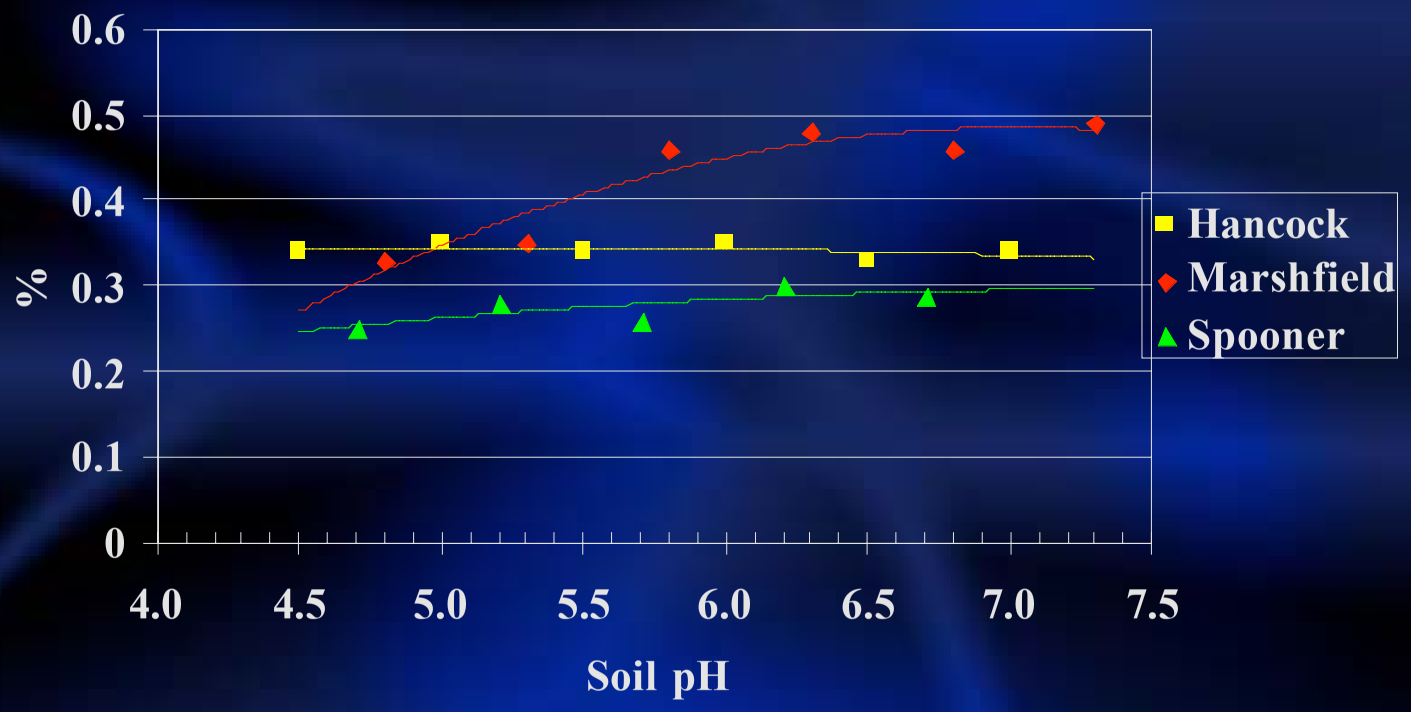
Alfalfa tissue Ca by K_2O rate (1998-2001)



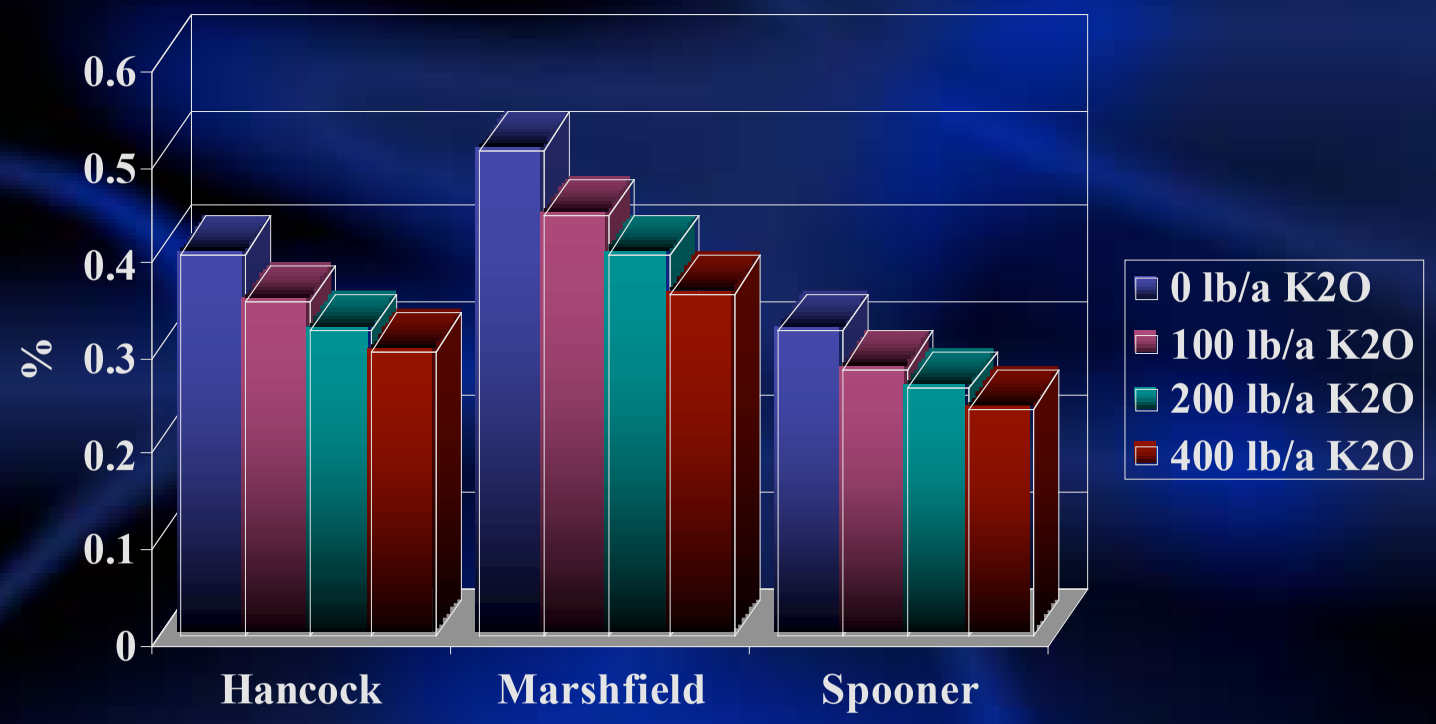
Effects of pH and K on alfalfa tissue Ca levels (Spooner, 1998-2001)



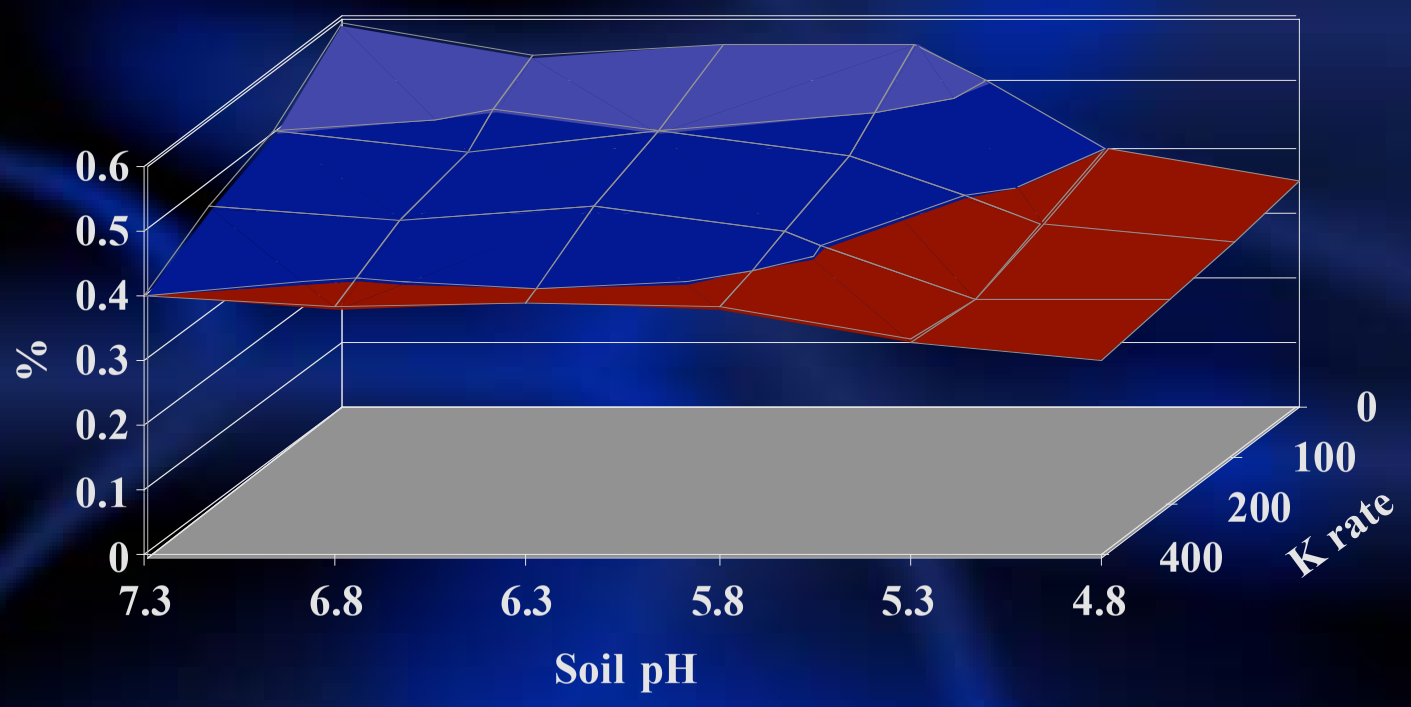
Alfalfa Mg level by soil pH



Alfalfa tissue Mg by K_2O rate (1998-2001)

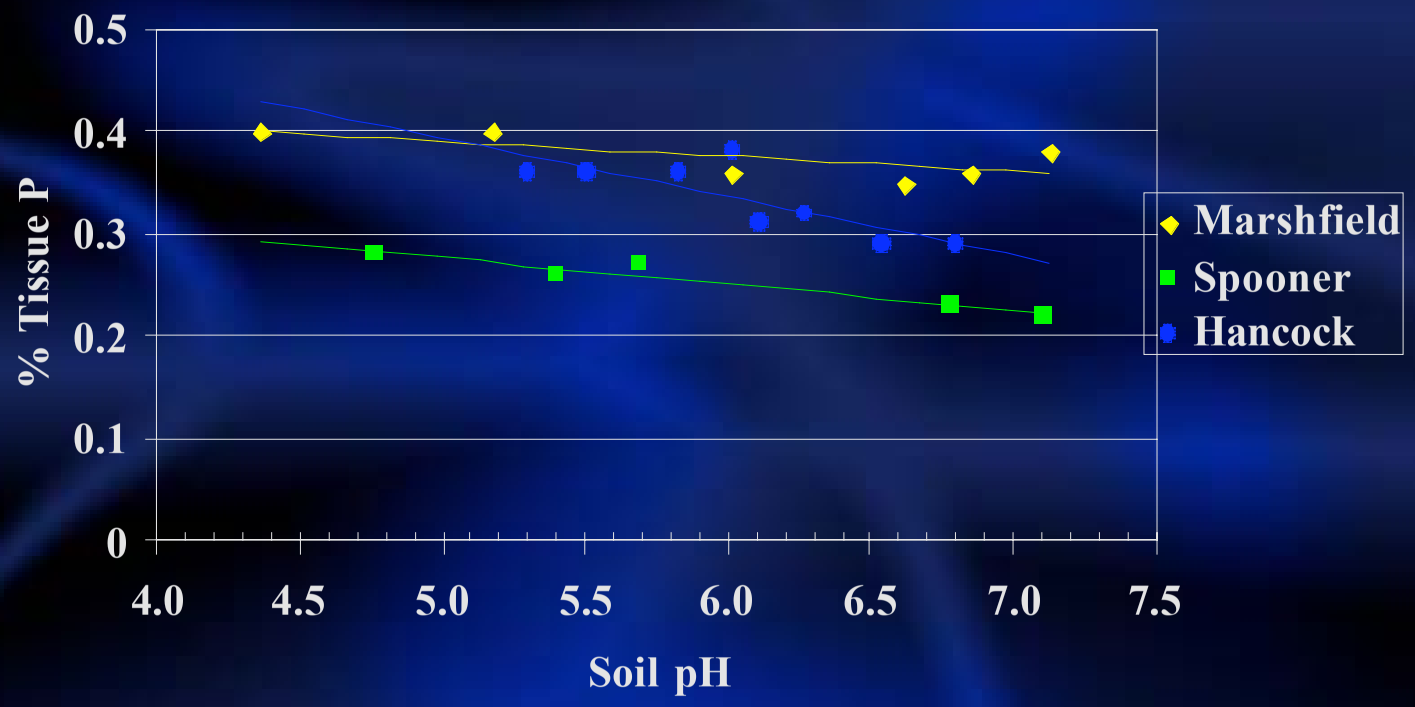


Effects of pH and K on alfalfa tissue Mg levels (Marshfield, 1998-2000)



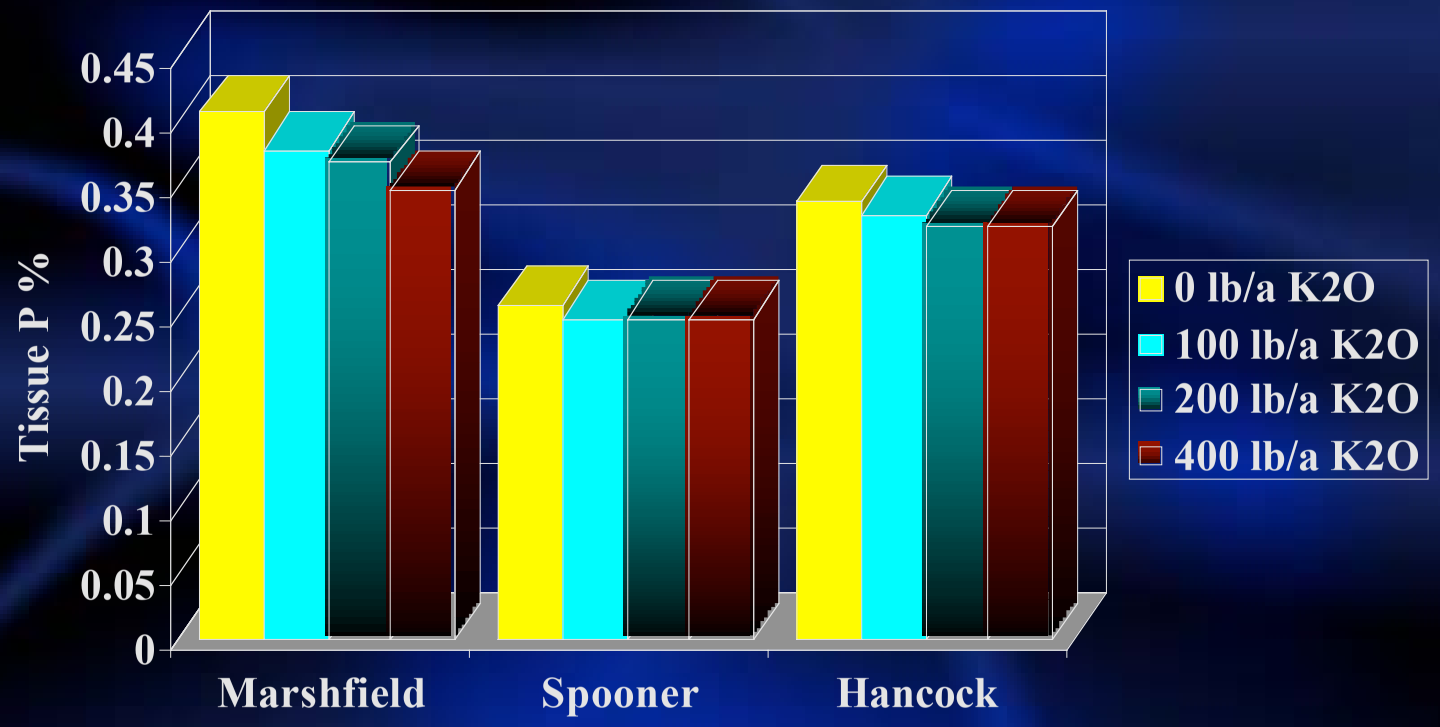
Alfalfa Tissue P Levels

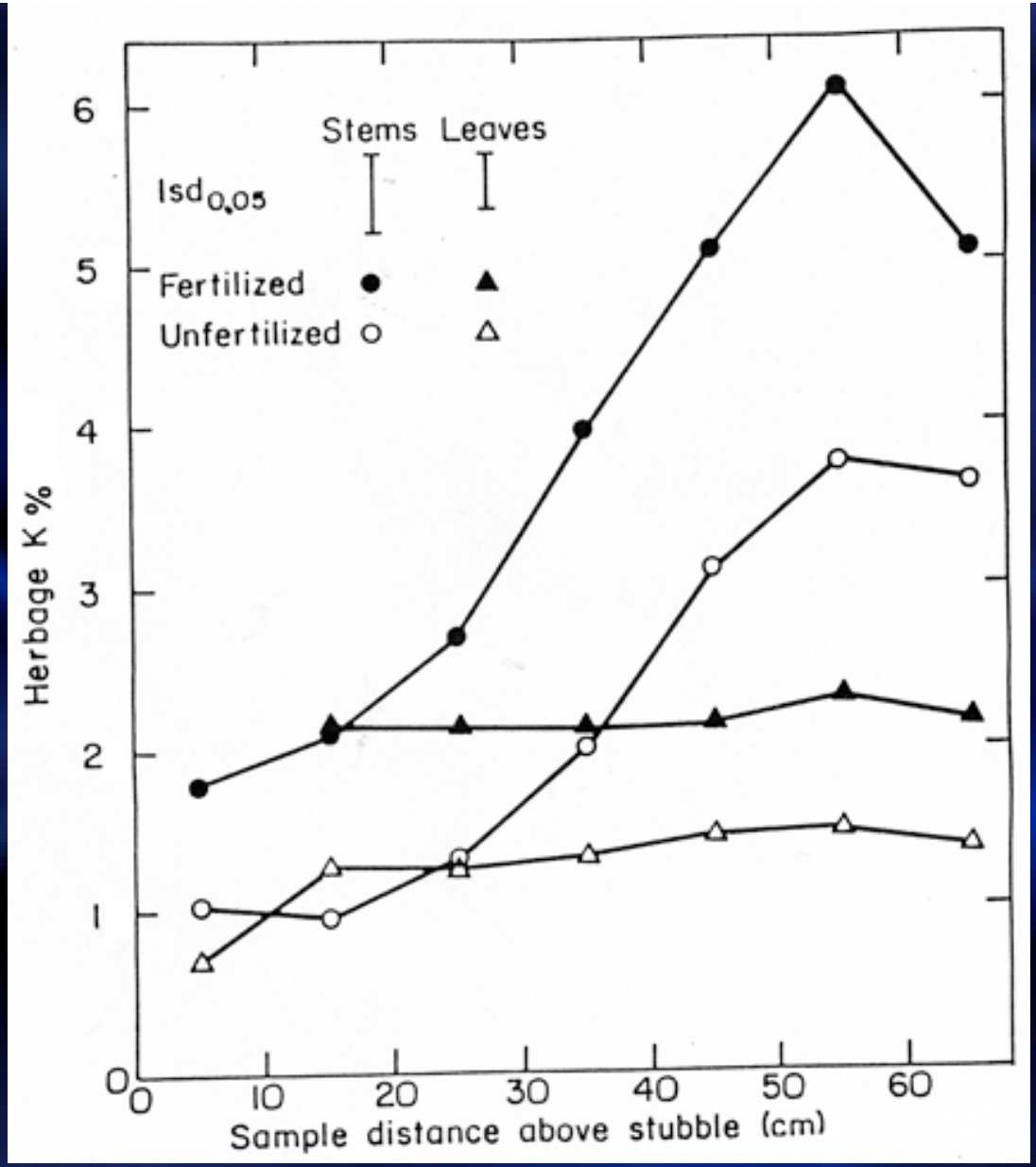
3rd cut, 1999



Average Tissue P Levels

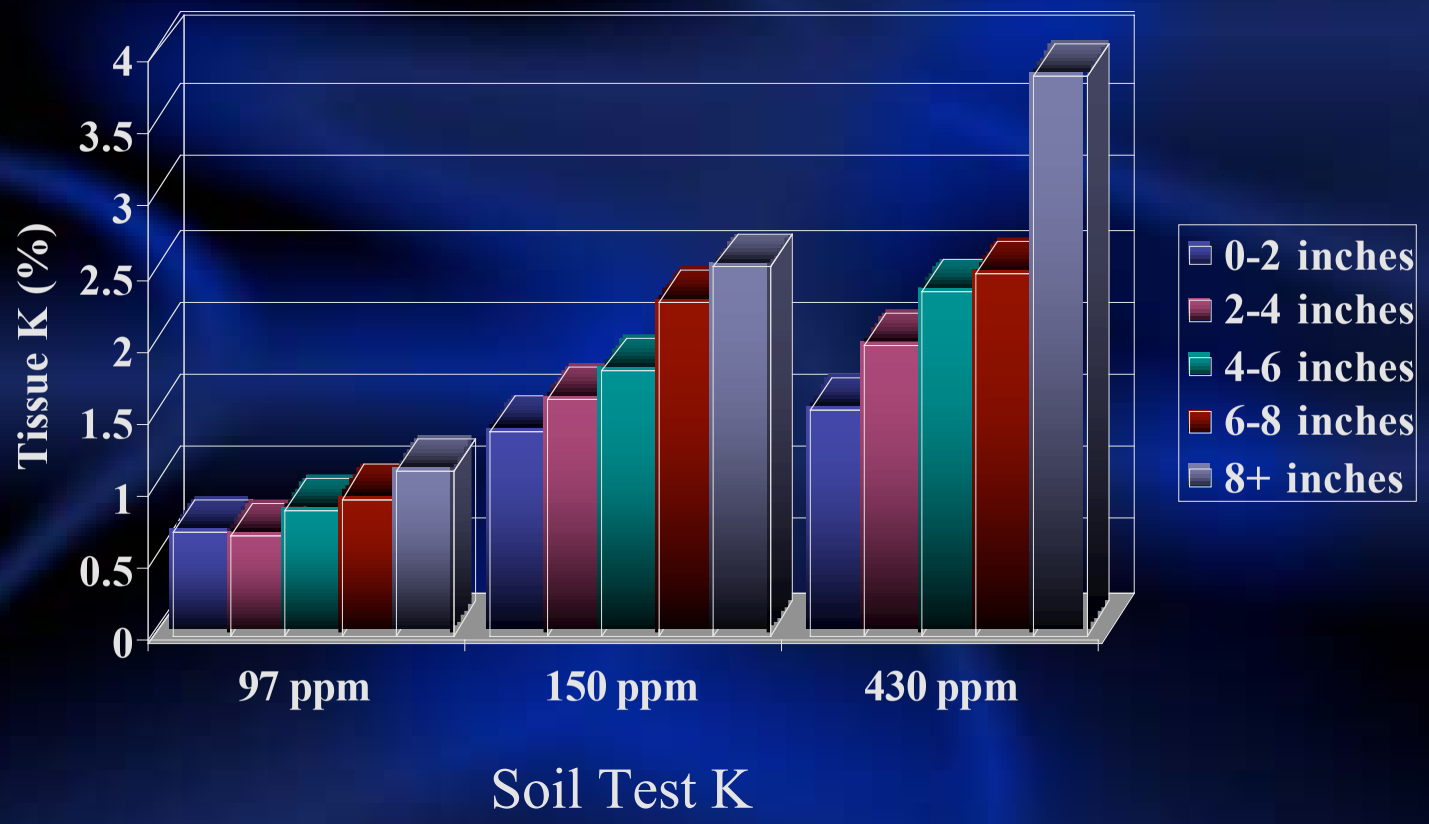
3rd cut alfalfa, 1999



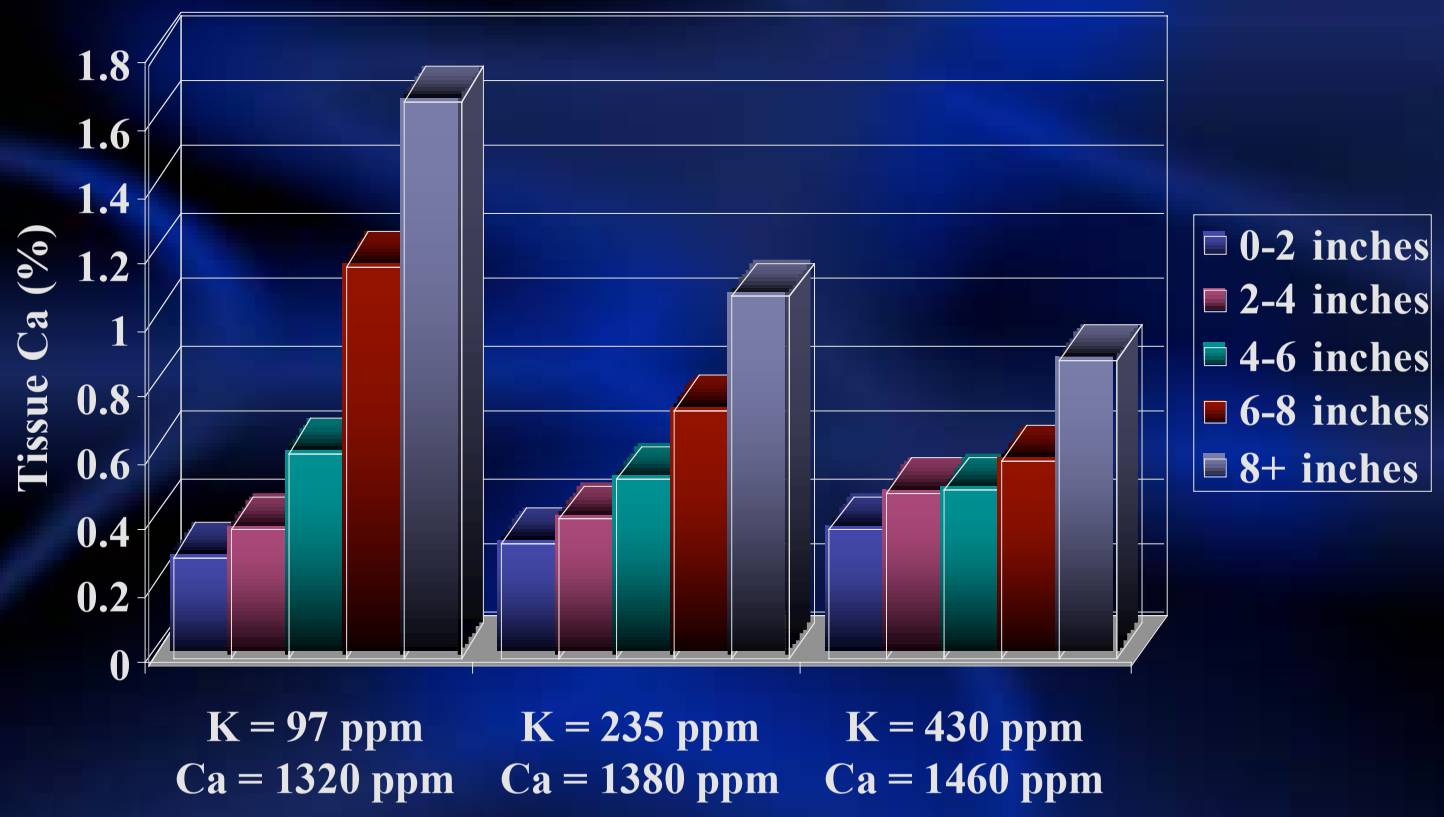


Rominger et al., 1975

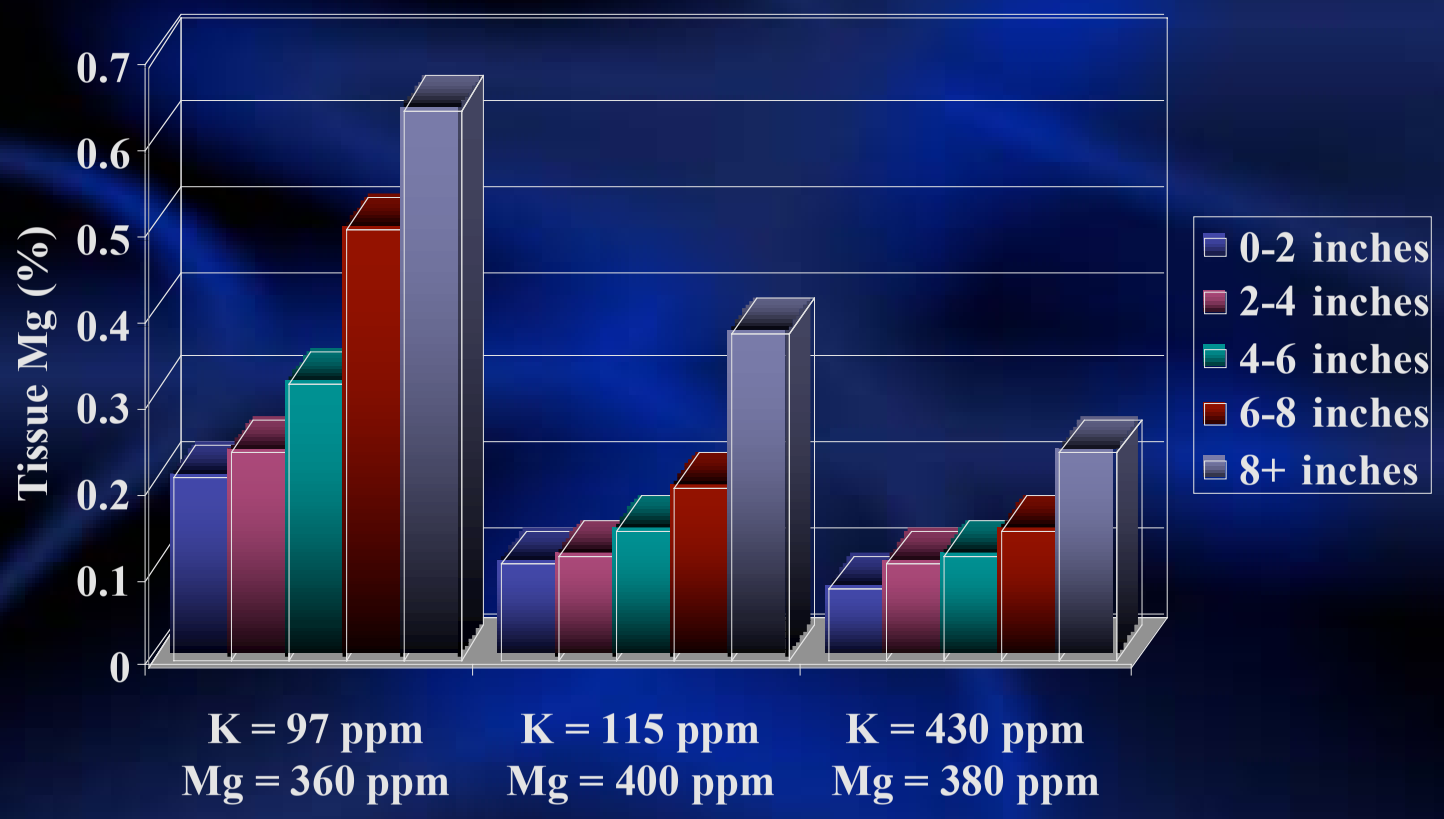
Alfalfa tissue K level by height, first cut Marshfield 2002



Alfalfa tissue Ca level by height, first cut Marshfield 2002

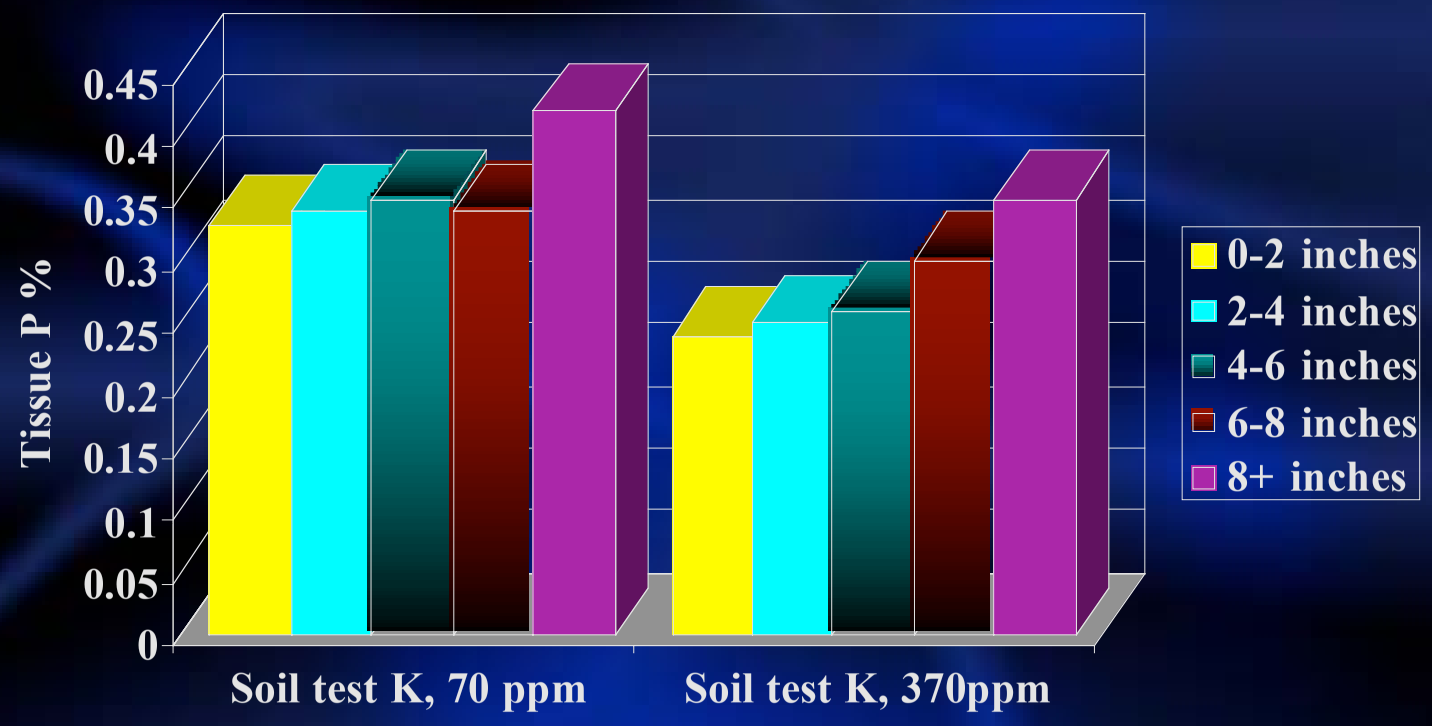


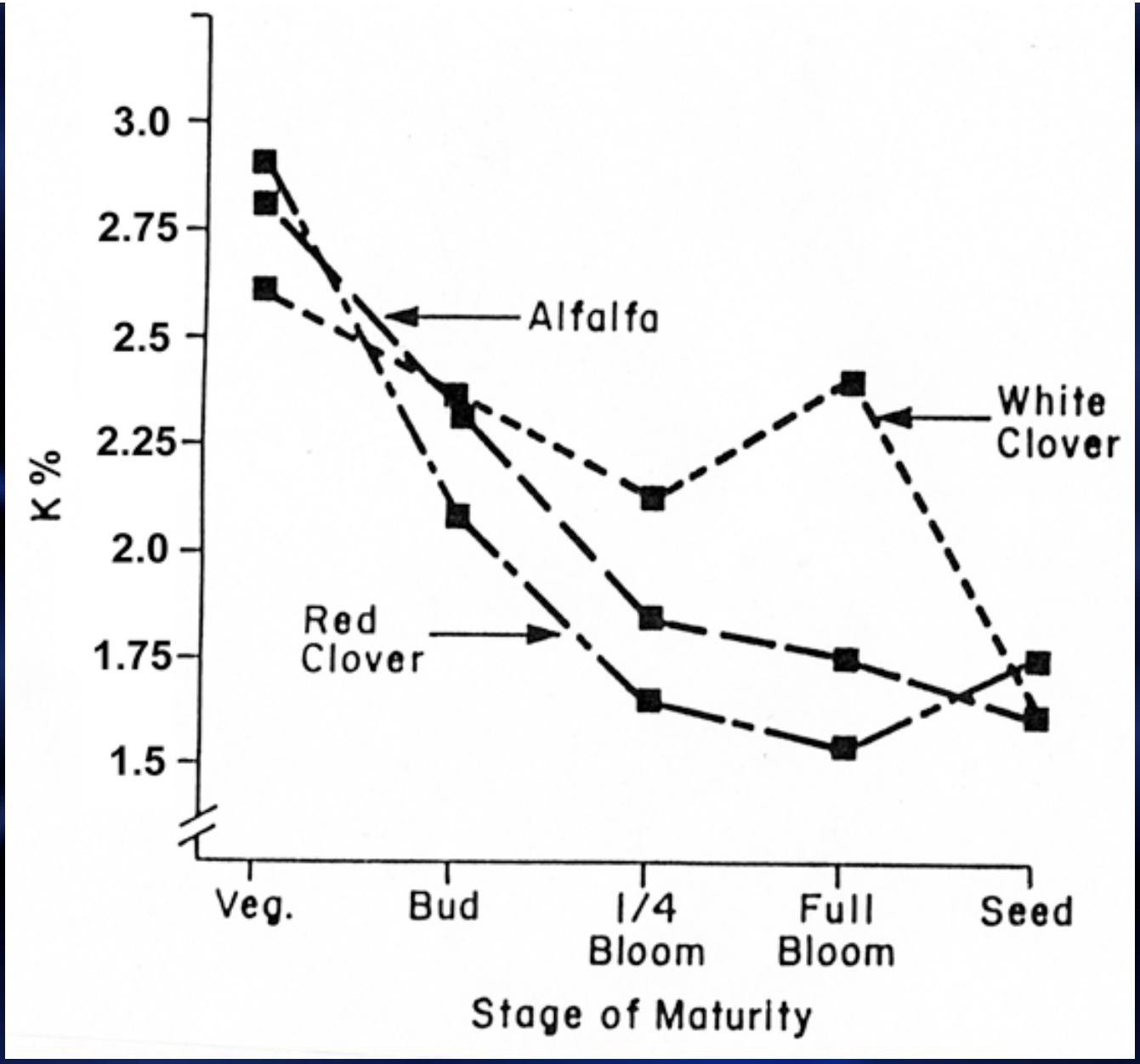
Alfalfa tissue Mg level by height, first cut Marshfield 2002



Alfalfa Tissue P Levels

3rd cut, 2001

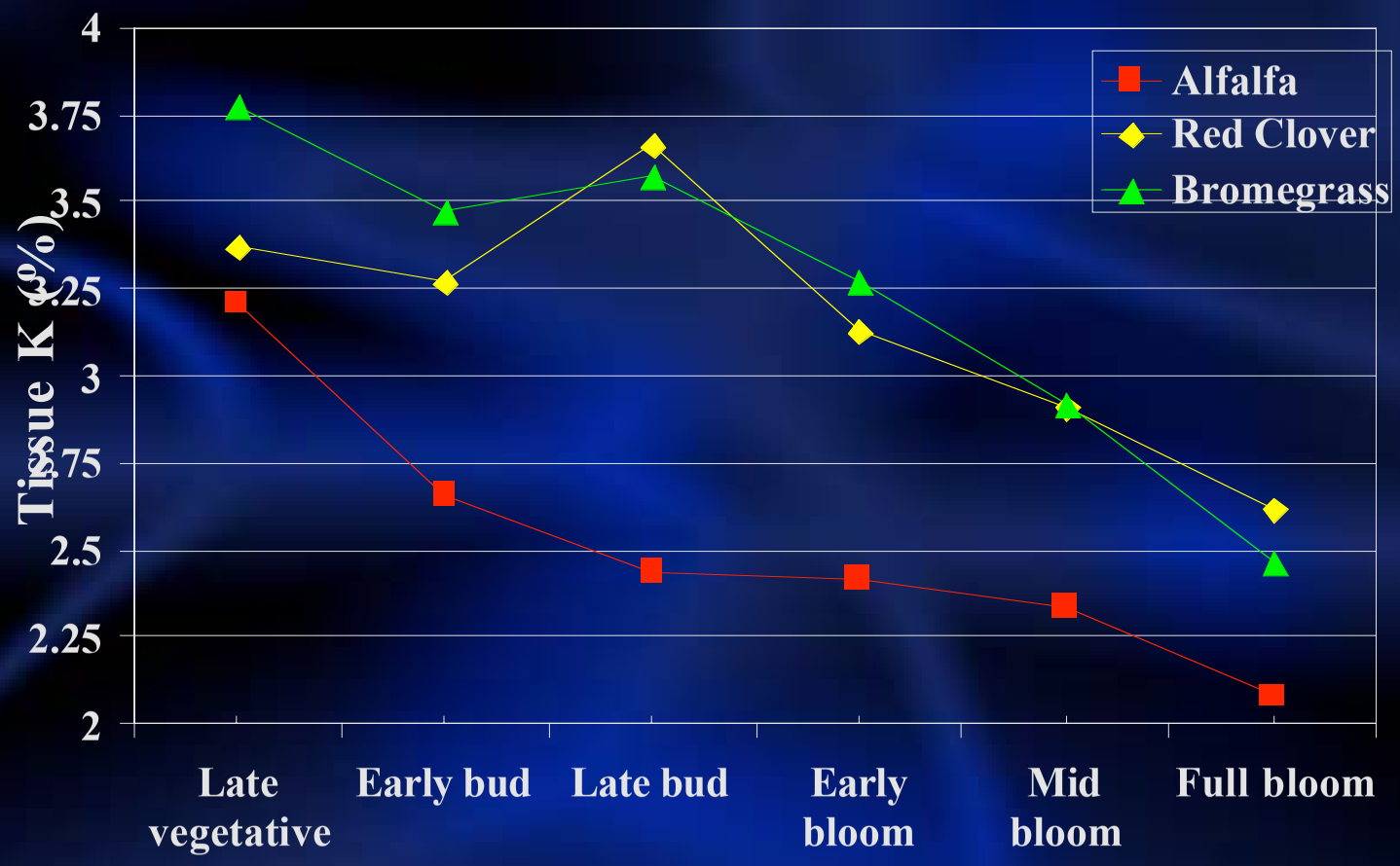




Baker and Reid, 1977

K composition of perennial forages

(Hoffman, et al. 1994)



Comparison of forage K levels of legumes and legume-grass mixtures

	Cut 1	Cut 2	Cut 3	Average
	---------- % K ----------			
Alfalfa	3.82	2.97	2.36	3.05
with ryegrass	3.45	3.80	2.24	3.16
Red Clover	3.50	3.77	2.38	3.22
with ryegrass	4.14	3.26	2.56	3.32
Birdsfoot Trefoil	3.14	3.22	2.42	2.93
with ryegrass	4.33	2.92	2.86	3.37

Ten-year average forage mineral content

	Ca	P	K	Mg
	--------- % (*DM basis*) ---------			
Legume hay	1.20	0.30	2.71	0.32
Legume silage	1.14	0.32	2.86	0.30
Legume-grass hay	1.01	0.27	2.25	0.29
Legume-grass silage	1.08	0.33	2.84	0.32
Grass hay	0.71	0.36	1.89	0.27
Grass silage	0.59	0.35	2.92	0.27
Corn silage	0.28	0.24	1.18	0.21
Small grain silage	0.94	0.29	2.51	0.26

UW Soil & Forage Analysis Lab, Marshfield, WI (1992-2001)

Summary

- Soil pH has a significant effect on cation levels found in forage tissue
- Applying K has a significant influence on all tissue cation levels
- As soil K increases, tissue K increases and tissue Ca and Mg tend to decrease.
- Typically, mineral P levels are not greatly affected by the presence of high levels of K.

Summary

- Apply nutrients according to soil test recommendations. High K levels will lead to “luxury consumption” in forages.
- If reducing K is your goal – clip forage lower, and allow the forage to mature a bit more than normal.
- Keep low K forages separated in storage.

UW
Soil
Science
Extension