

Fertility Management of Alfalfa for Manitoba

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**Manitoba
Agriculture**

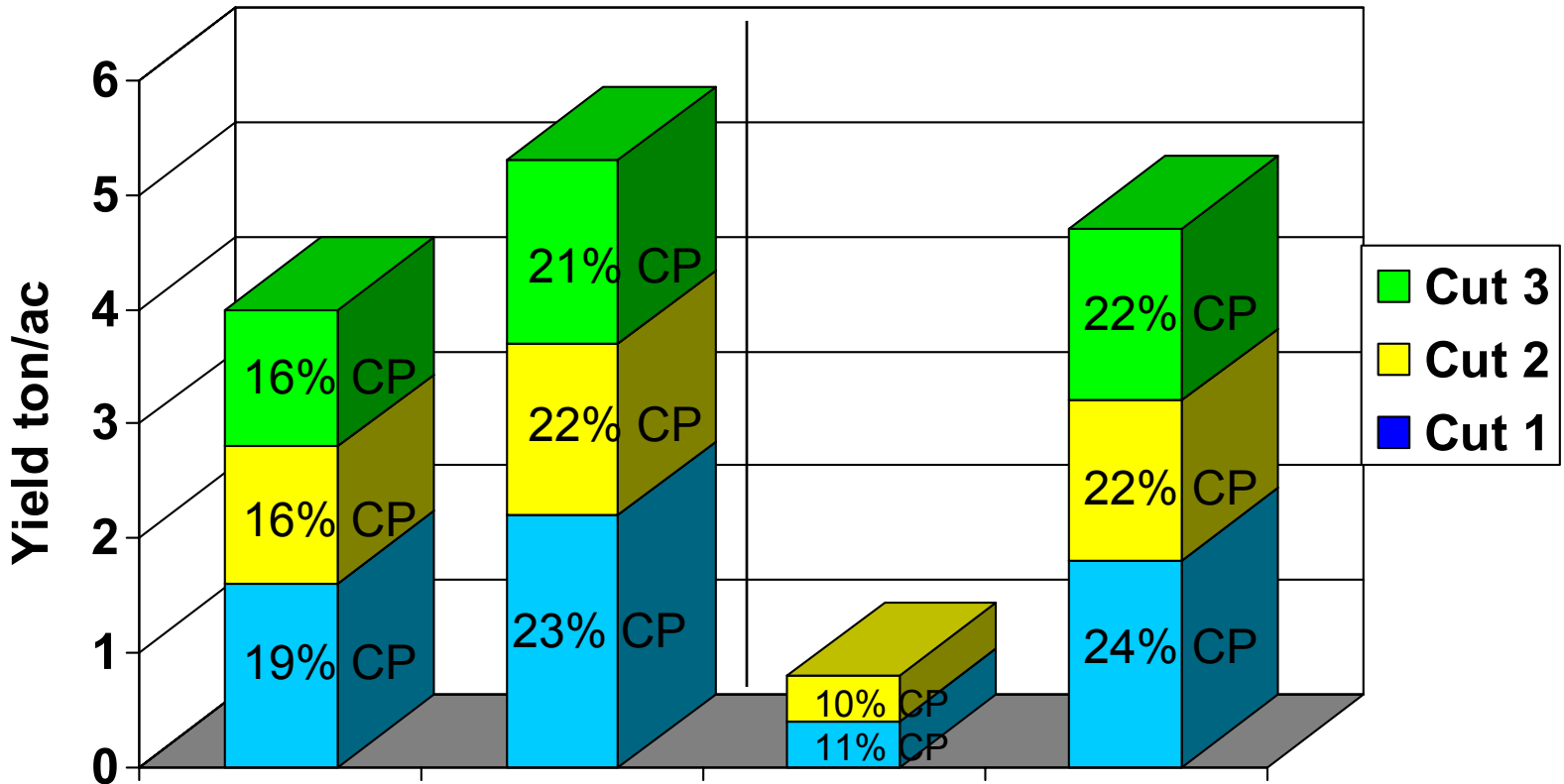


Introduction

Focus on alfalfa (in Manitoba – much forage is seeded to mixed alfalfa-grass stands for some very good reasons)

- Nutrient removal
- N fixation
- Phosphorus
- Potassium
- Sulphur
- Boron
- Many Manitoba studies reported.

Alfalfa response to fertilization



5 yr-ave on clay loam soil
0 - 54 P₂O₅ - 27 K₂O - 27S

5 yr-ave on sandy loam soil
0 - 54 P₂O₅ - 107 K₂O - 27S

Bailey, MB

Thumbrule (p.2 SFG)

Every ton of alfalfa removes:

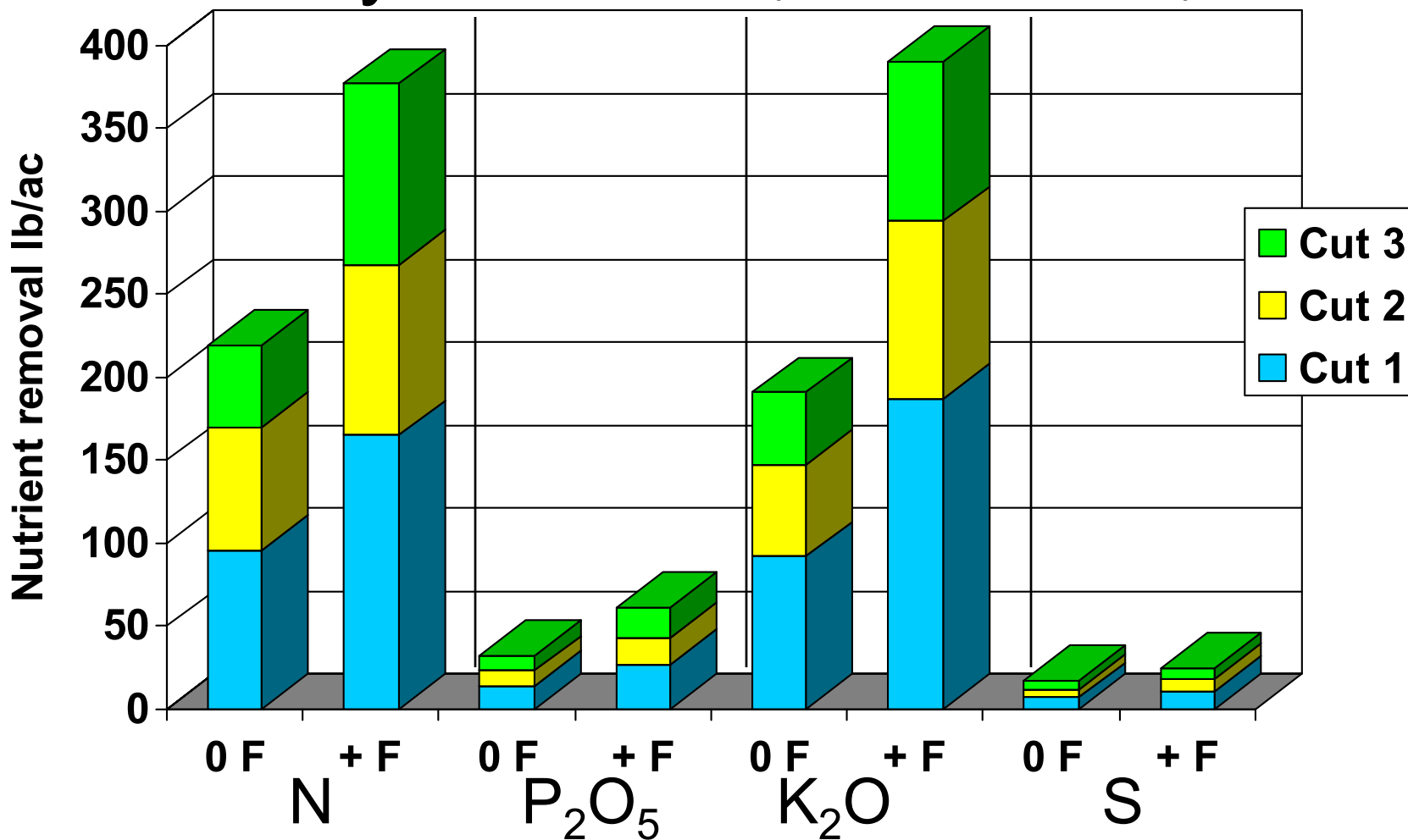
- 60 lb N
- 15 lb P_2O_5
- 60 lb K_2O
- 6 lb S

@ 3 ton/yr = 180 – 45 – 180 - 18

Over 5 yr life = 900 – 225 – 900 - 90

Nutrient uptake and removal by alfalfa

– clay loam soil (4.0 vs 5.3 ton/ac)

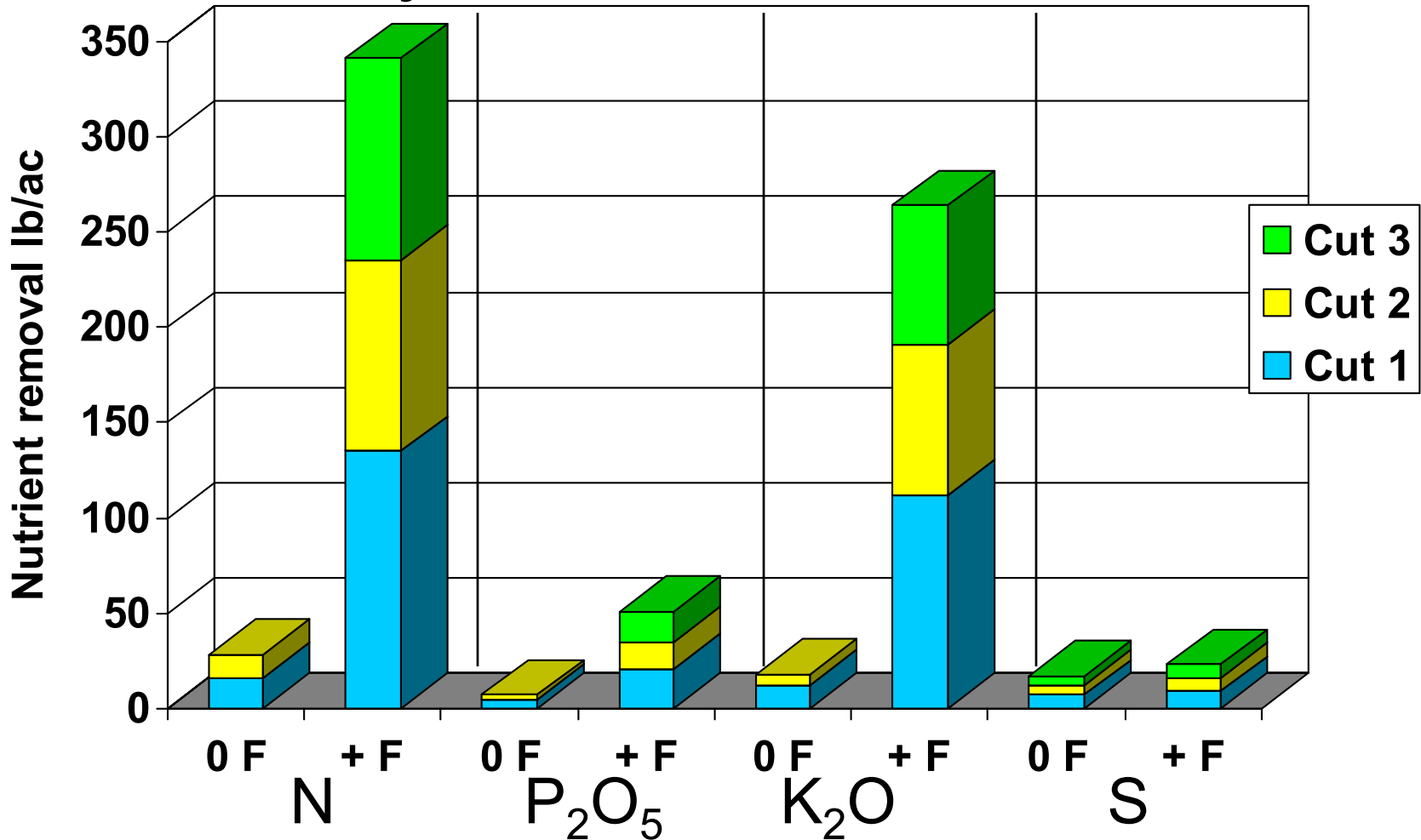


5 yr-ave on clay loam soil

+F = fertilized with 0 - 54 P₂O₅ - 27 K₂O - 27S (Bailey, MB)

Nutrient uptake and removal by alfalfa

– sandy loam soil (0.8 vs 4.7 ton/ac)



5 yr-ave on sandy loam soil

+F = fertilized with 0 - 54 P₂O₅ - 107 K₂O - 27S

(Bailey, MB)

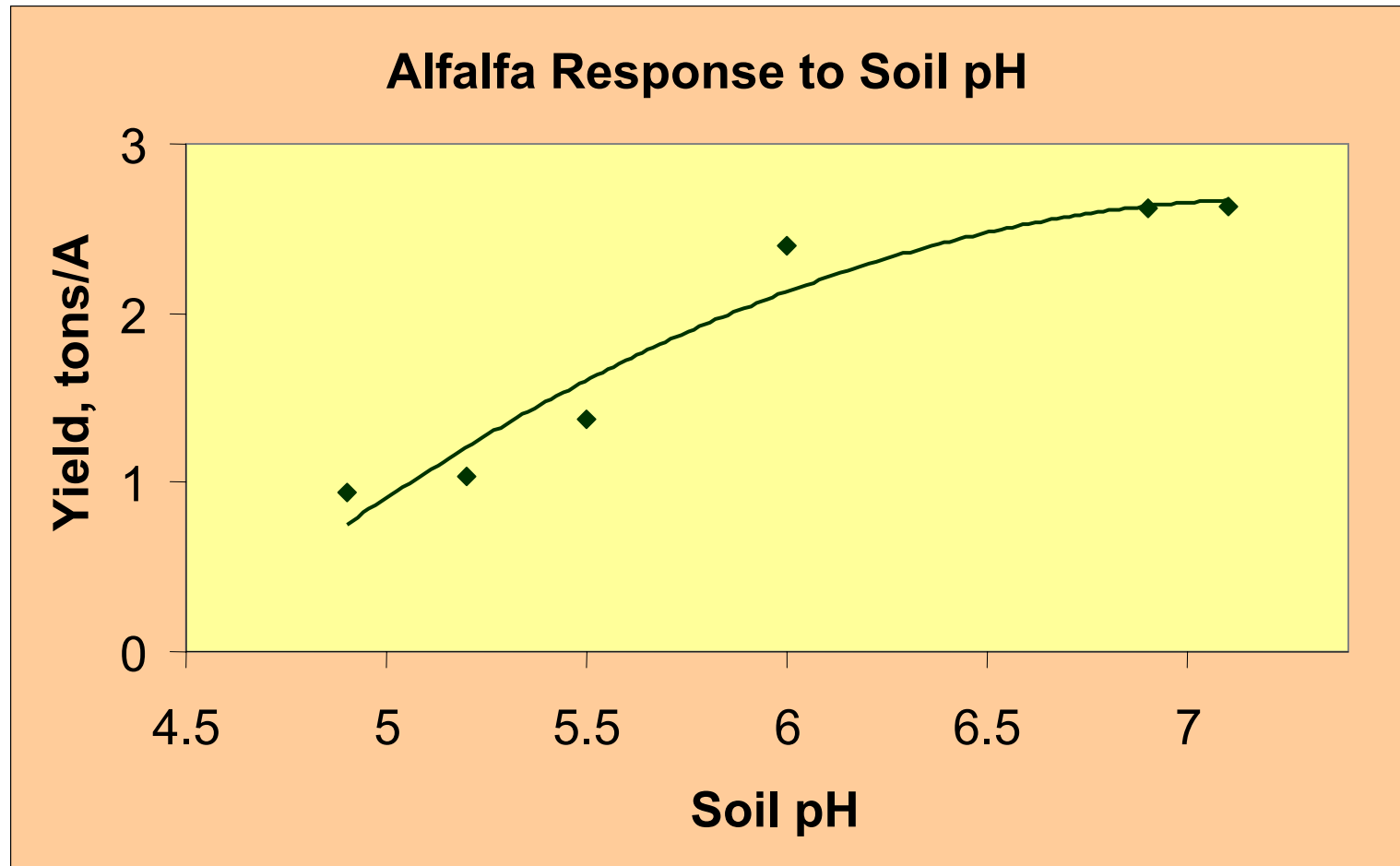
Alfalfa Inoculation

- Successful inoculation is critical if alfalfa is to produce the 300+ lb N/ac/yr for high yields
 - Most seed is currently pre-inoculated or coated with an inoculant by seed companies
 - MB studies indicate Rhizobium mutate rapidly in soils – and are NOT selected for increased N fixing ability
 - Improved Rhizobium strains are selected through research
- eg: NRG-34 - isolated at Beaverlodge, AB was superior to existing strains on acidic and cool soils



no inoculant

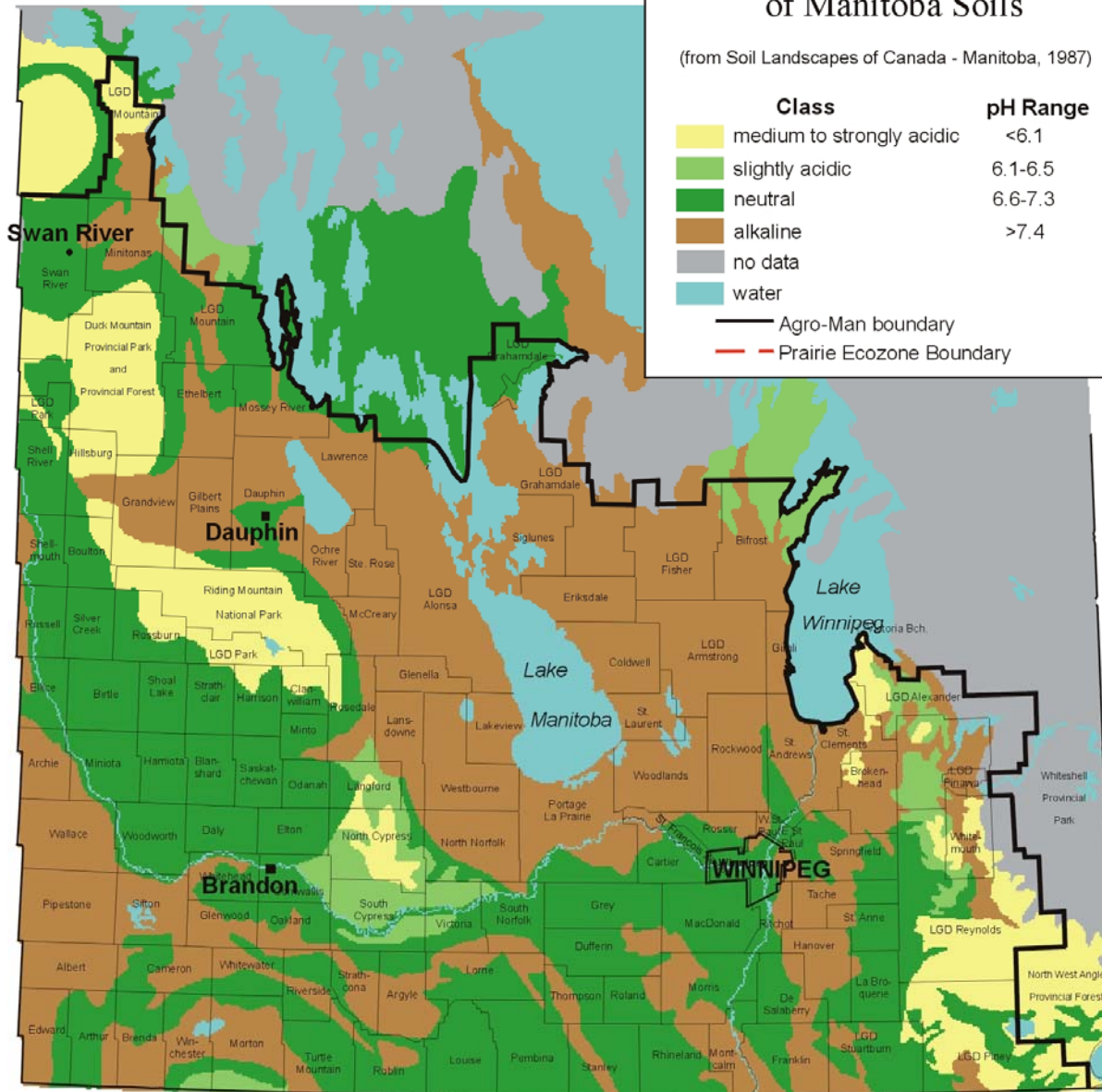
plus inoculant



Rhizobium bacteria are inhibited on acid soils.
N fixation is reduced and legume yields suffer.

pH Status of Manitoba Soils

(from Soil Landscapes of Canada - Manitoba, 1987)



Acid soil conditions are not common in Manitoba.

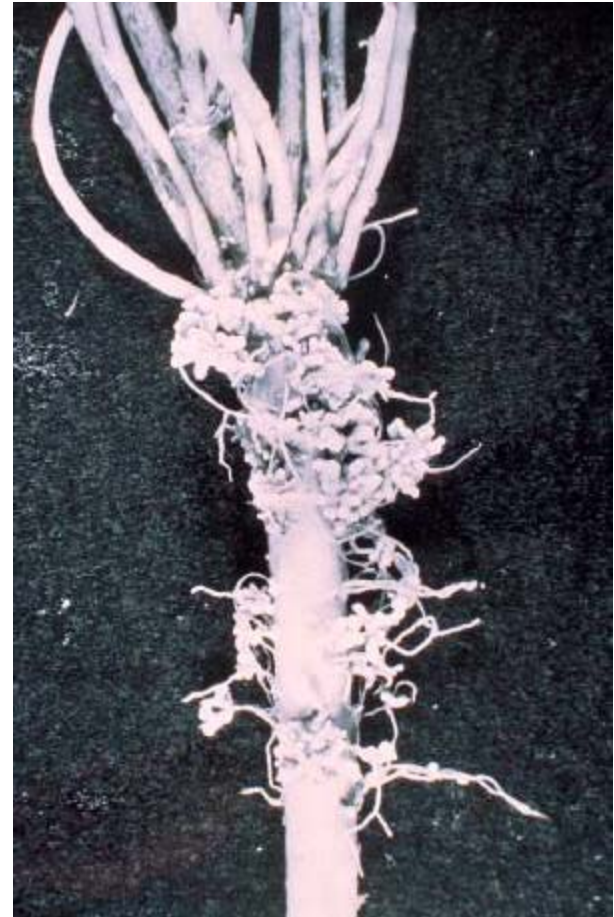
Areas with acid soil are:

- Forested soils in NW MB
- Keld soils west of Dauphin
- Carberry sands
- Sandilands in E MB
- Peat soils

•Soils in the agricultural areas in NW Ontario are acidic (Dryden and Thunder Bay) and wood ash is used to raise soil pH.

Checking for N - fixation

- Forage - pale green colour
- low protein content in feed tests or N tissue test (<2.5 %N)
- **Nodulation**
- takes 1 month after alfalfa emergence before nodules form on roots and begin fixing N
- dig roots at several areas of field
- examine crown area for clusters of nodules



Checking for N - fixation

- slice open several nodules from each plant
- effective nodules - pink to beefsteak red
- immature = creamy white
- ineffective = pale green
- number on nodules and rate of N-fixation peaks just before bloom.

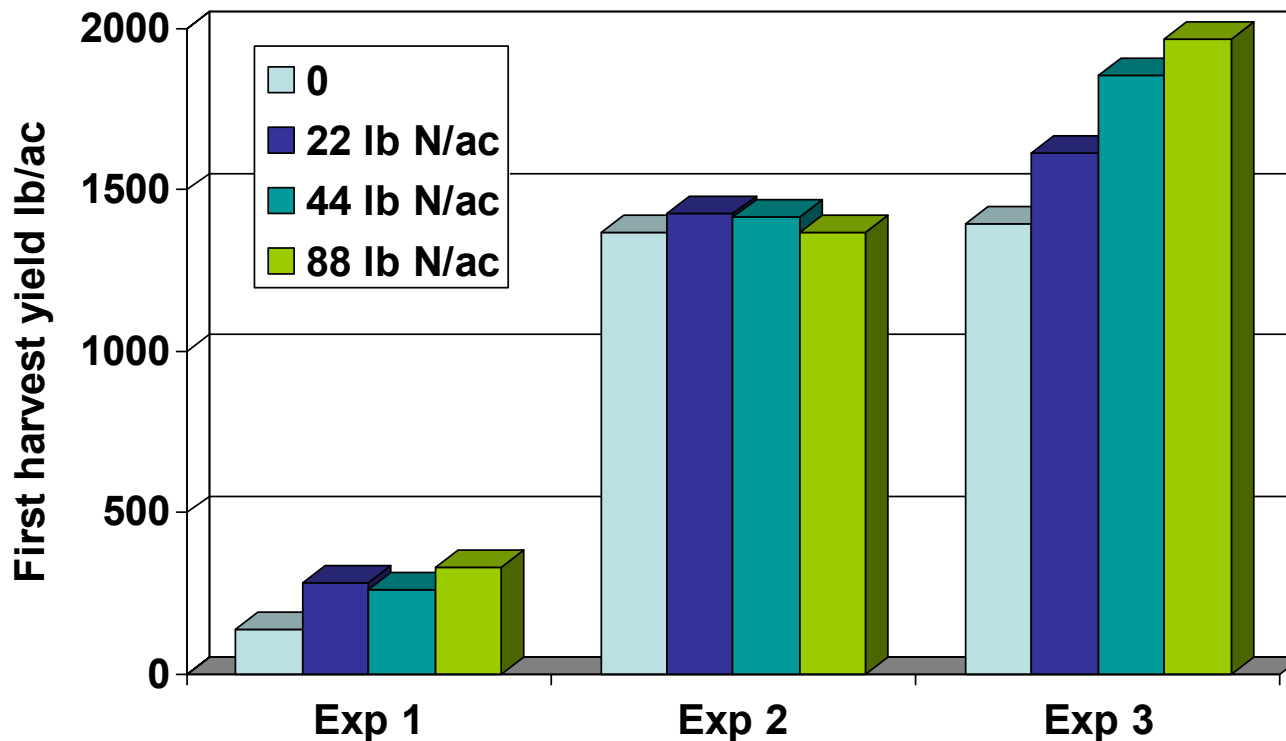


Soil factors reducing nodulation

- soil pH below 5.5
- dry or very warm soil (>20° C at seeding)
- sow inoculated seed into moist seedbeds on cool days

- Soil test – if soil pH is less than 6.0, request “buffer pH” analysis to determine appropriate lime rates.

Nitrogen for alfalfa establishment?



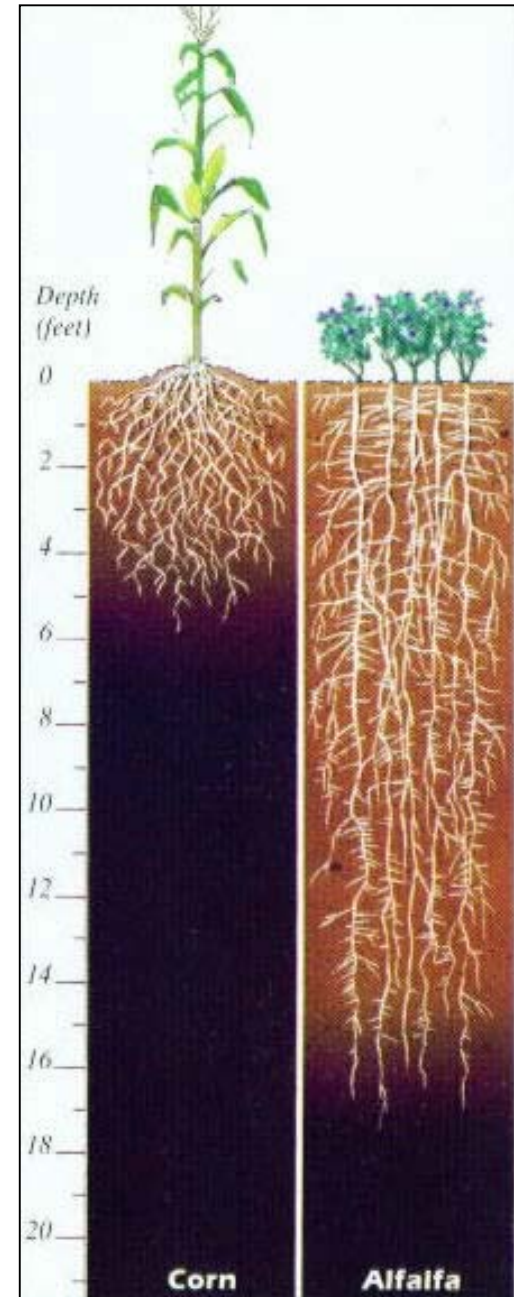
Summary

- Do not support use of N for alfalfa
- Weed growth encouraged in non-vigorous stands
- Rates above 44 lb N/ac reduced nodulation and subsequent alfalfa growth
- High yields obtained without N at 2/3 Exps.

Weed growth was increased with N at Exp 1.
No yield differences at any Exp by 2nd harvest.

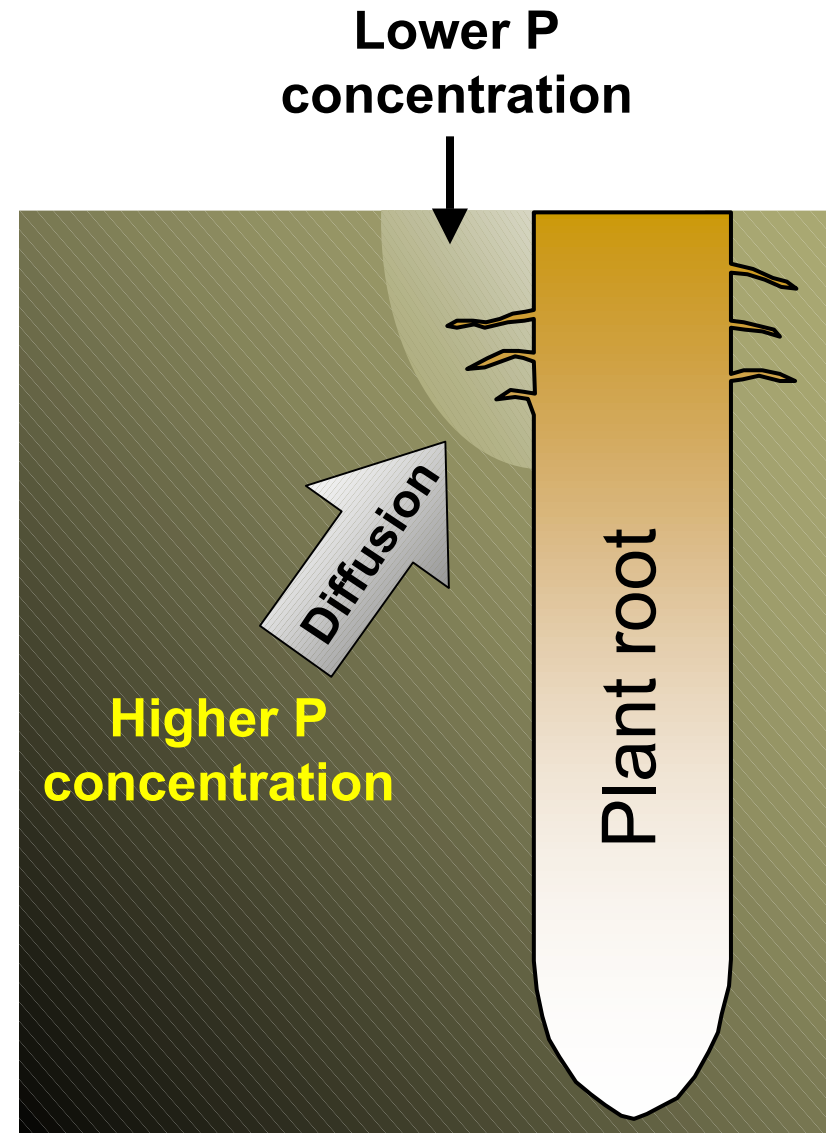
Alfalfa Root Development

- Most lateral roots are near the soil surface for the first year, but more deep lateral roots develop as the plant ages.
- Alfalfa has lower root density than many grasses and a deeper rooting zone.
- P and K application increase root growth, enabling roots to obtain moisture and nutrients from greater volume of soil.



The primary cause of low, short term uptake of P fertilizer:

The inability of P to move to absorbing roots



Temperature Effect on Nutrient Uptake

Cool soil temperatures will:

- slow nutrient release from soil organic matter
- reduce diffusion of nutrients to the roots
- hinder root absorption and translocation

Adequate P is essential for strong root systems

Higher levels of nutrients are needed to support vigorous plant growth in cool soil conditions.

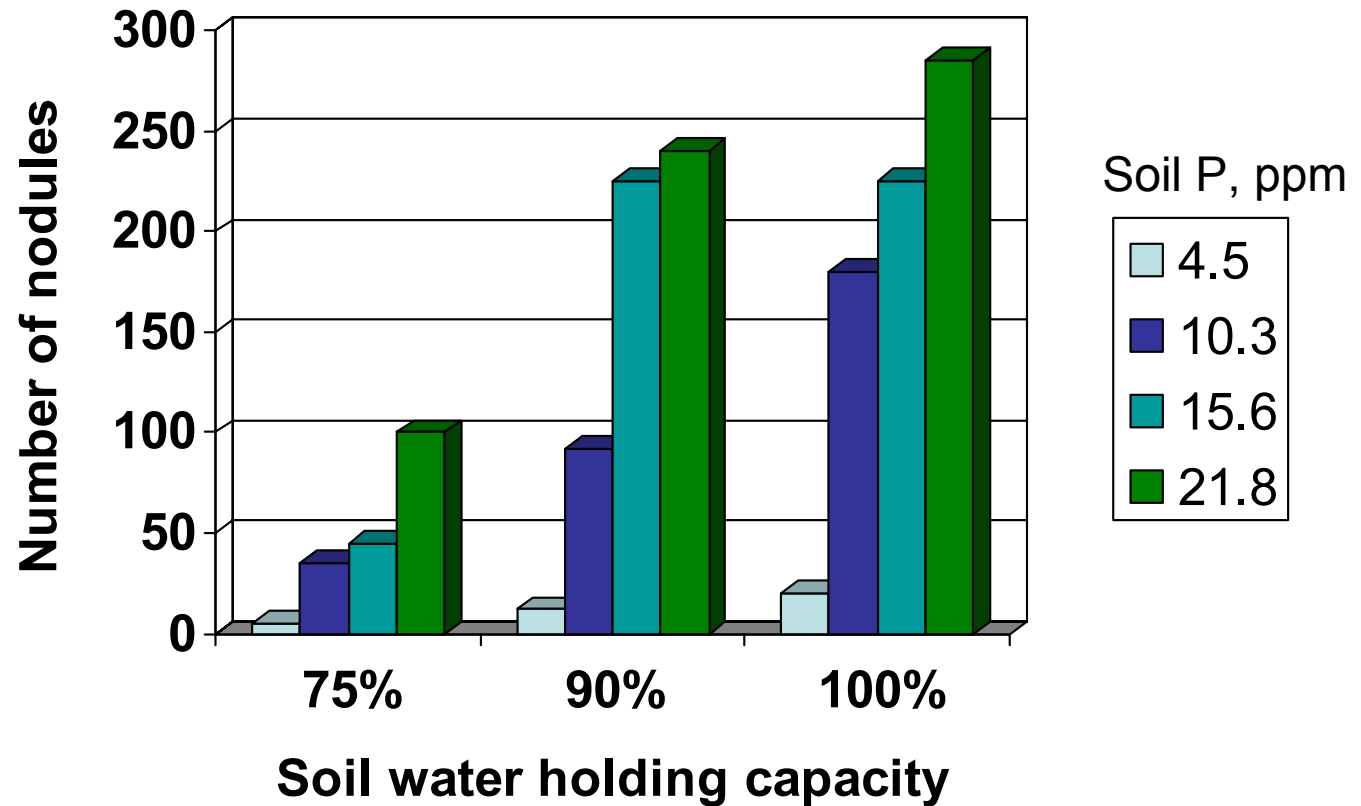


Phosphorus Functions in Plants

- Energy storage and transfer
 - Phosphate compounds are “energy currency”
 - (such as ADP and ATP)
- Structural component of biochemicals
 - Seed formation
 - Calcium and magnesium phytate
- Maintenance and transfer of genetic code
- Root growth, rapid crop establishment
- Early maturity, quicker recovery



P Fertilization Increases Nodulation

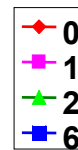
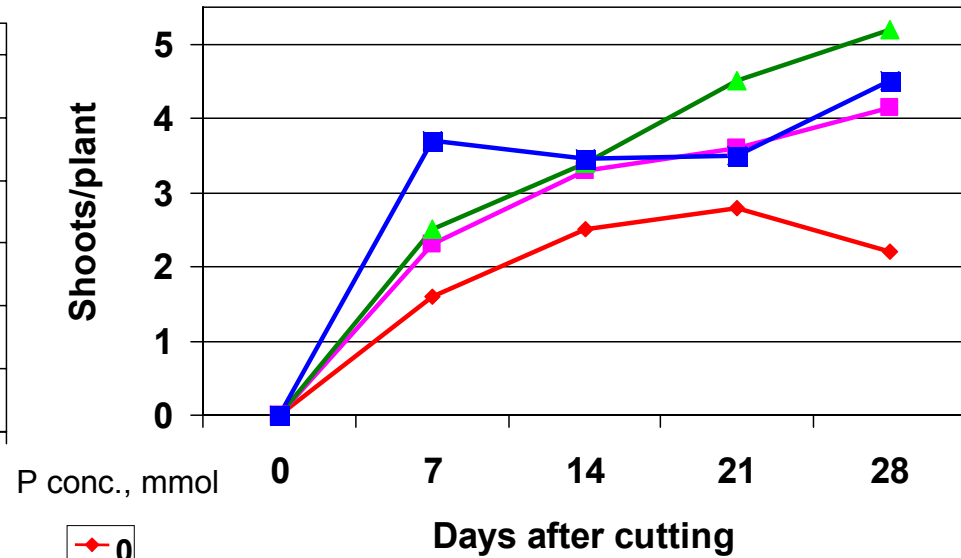
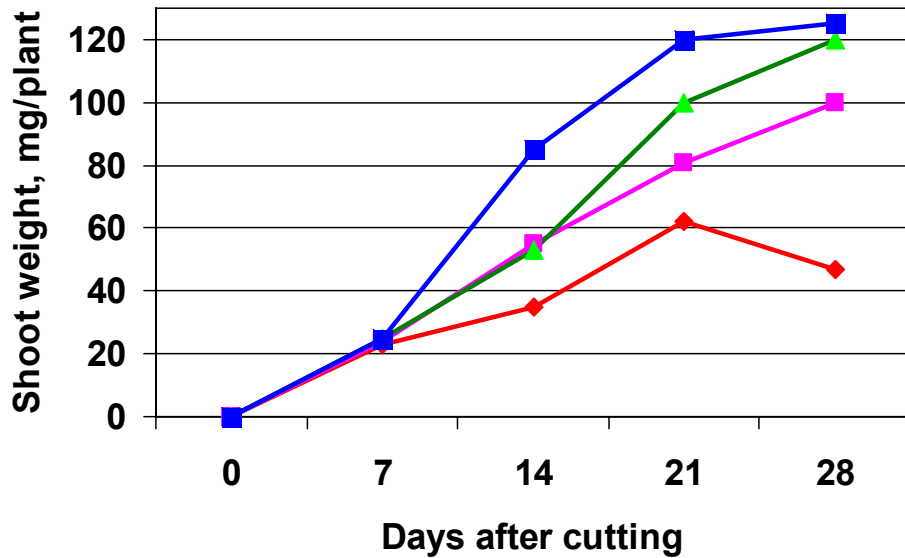


P Improves Alfalfa Growth and Recovery

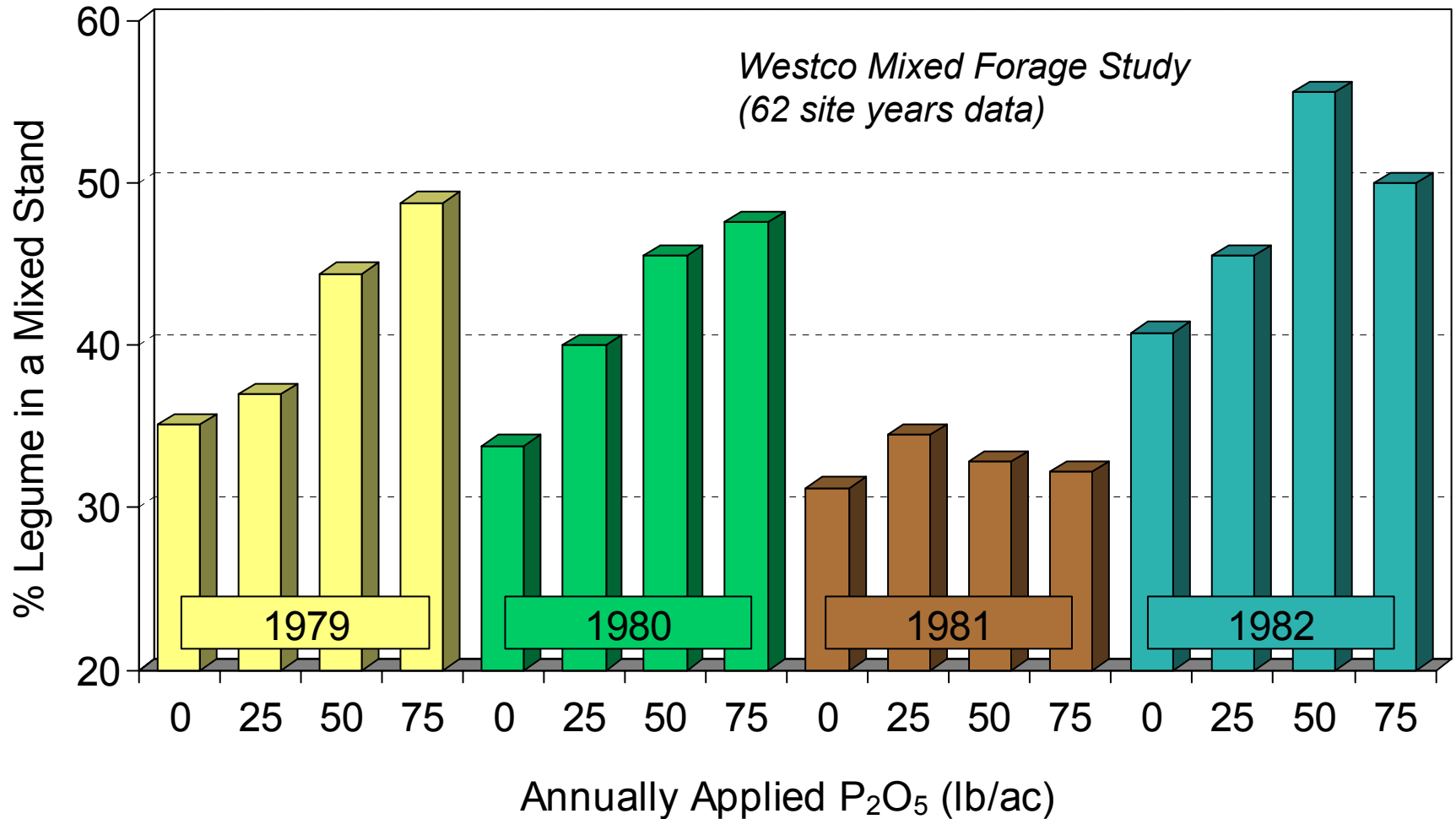


Alfalfa regrows faster after cutting with adequate P

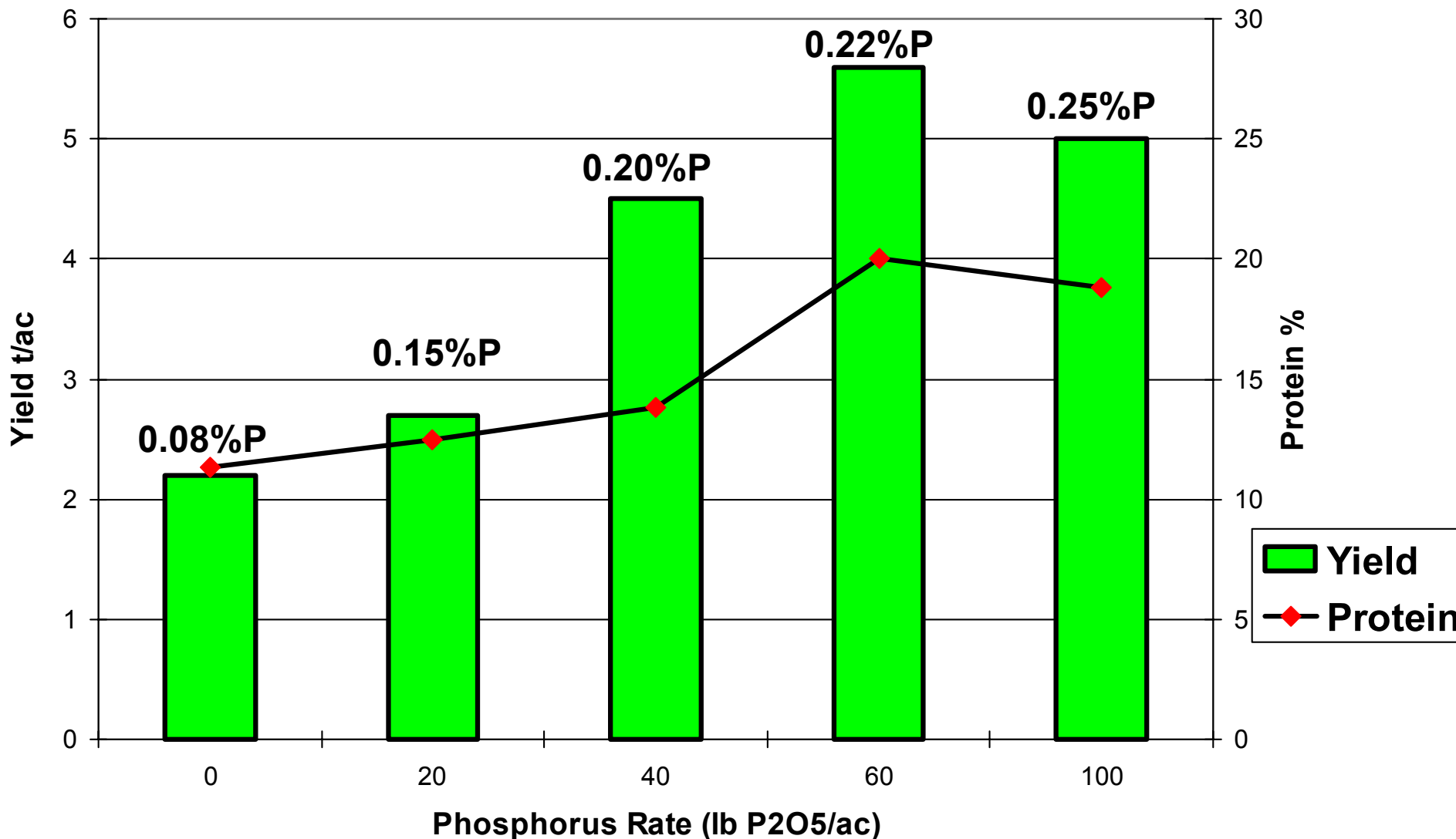
Alfalfa develops more shoots after cutting with adequate P



Phosphate Promotes Legume Growth



Effect of P on Alfalfa Yield, Protein and P Content

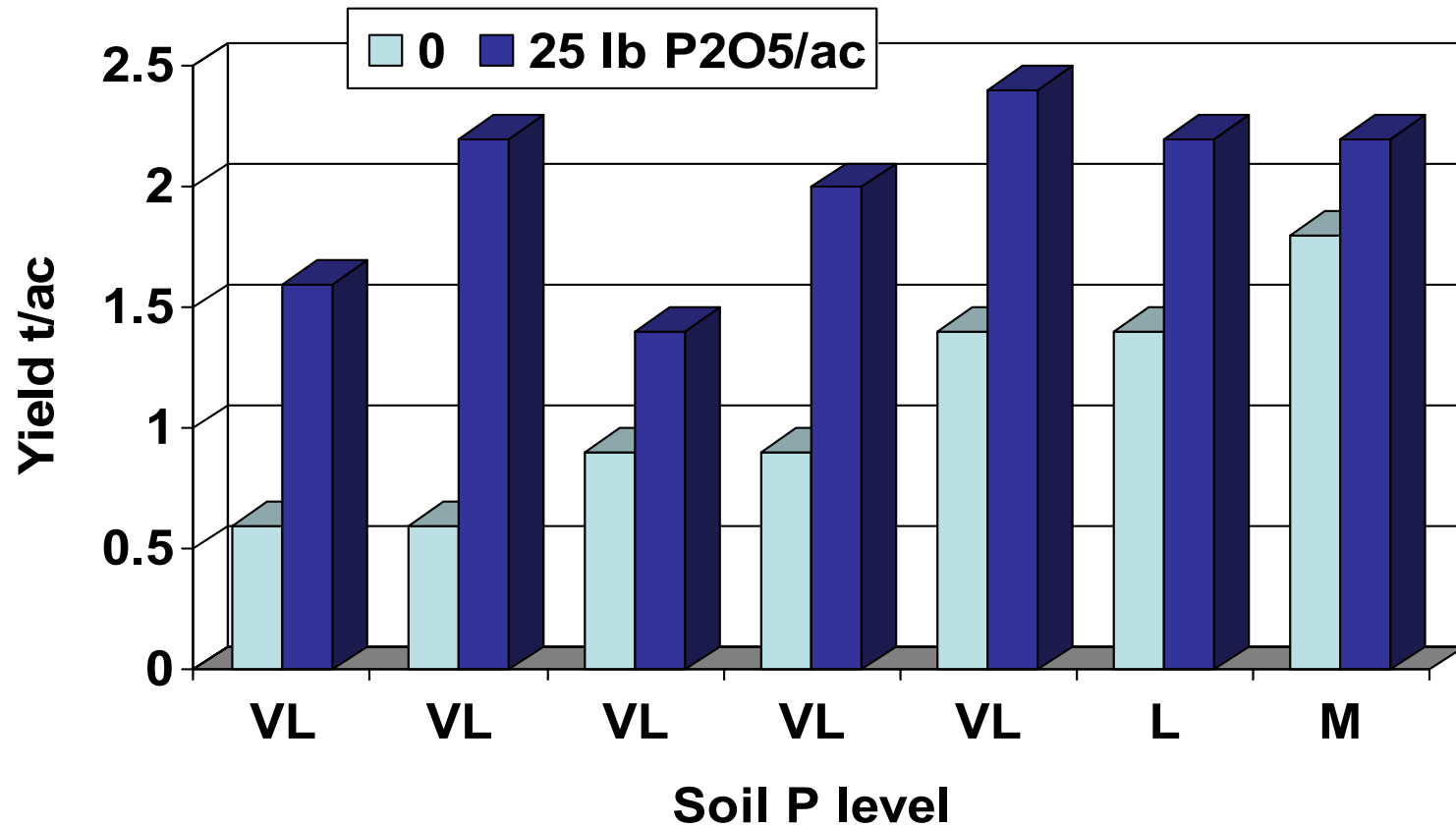


5 station years on 3 MB soils.

Initial soil P = 3 -11 ppm. Plots fertilized annually with 30 lb K₂O/ac and 30 lb S/ac.

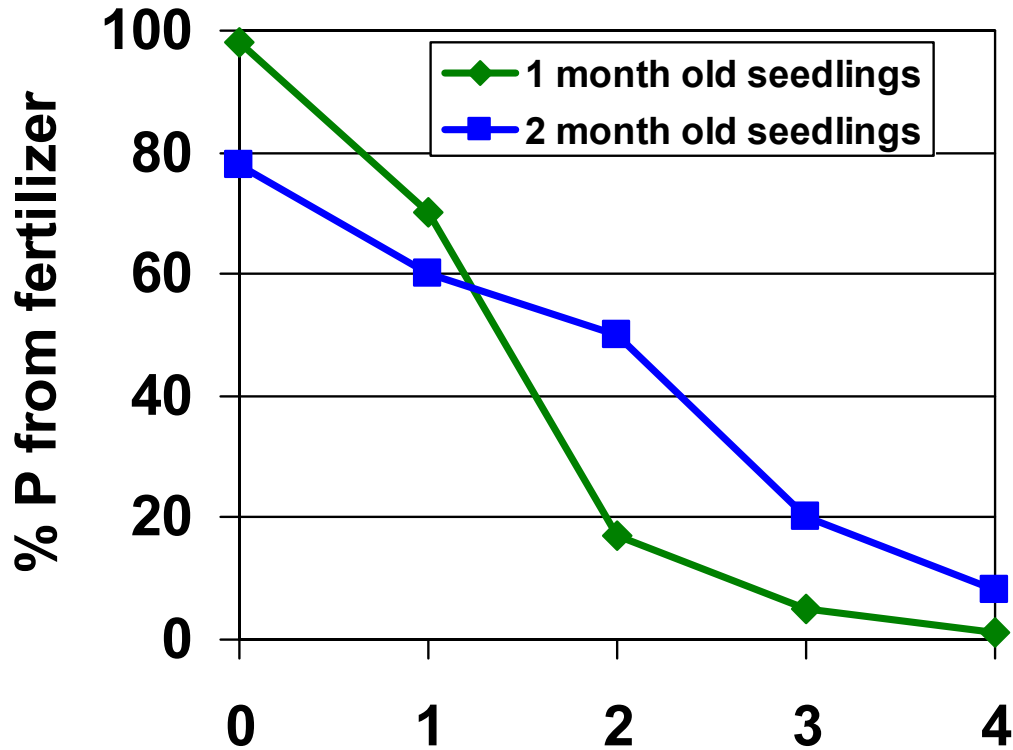
P Yield response Varies by Soil Test P

Alfalfa grass- 4yr average



P response on 7 MB soils.

Alfalfa benefits from banding directly over P fertilizer



Lateral distance in inches between
seedlings and fertilizer band

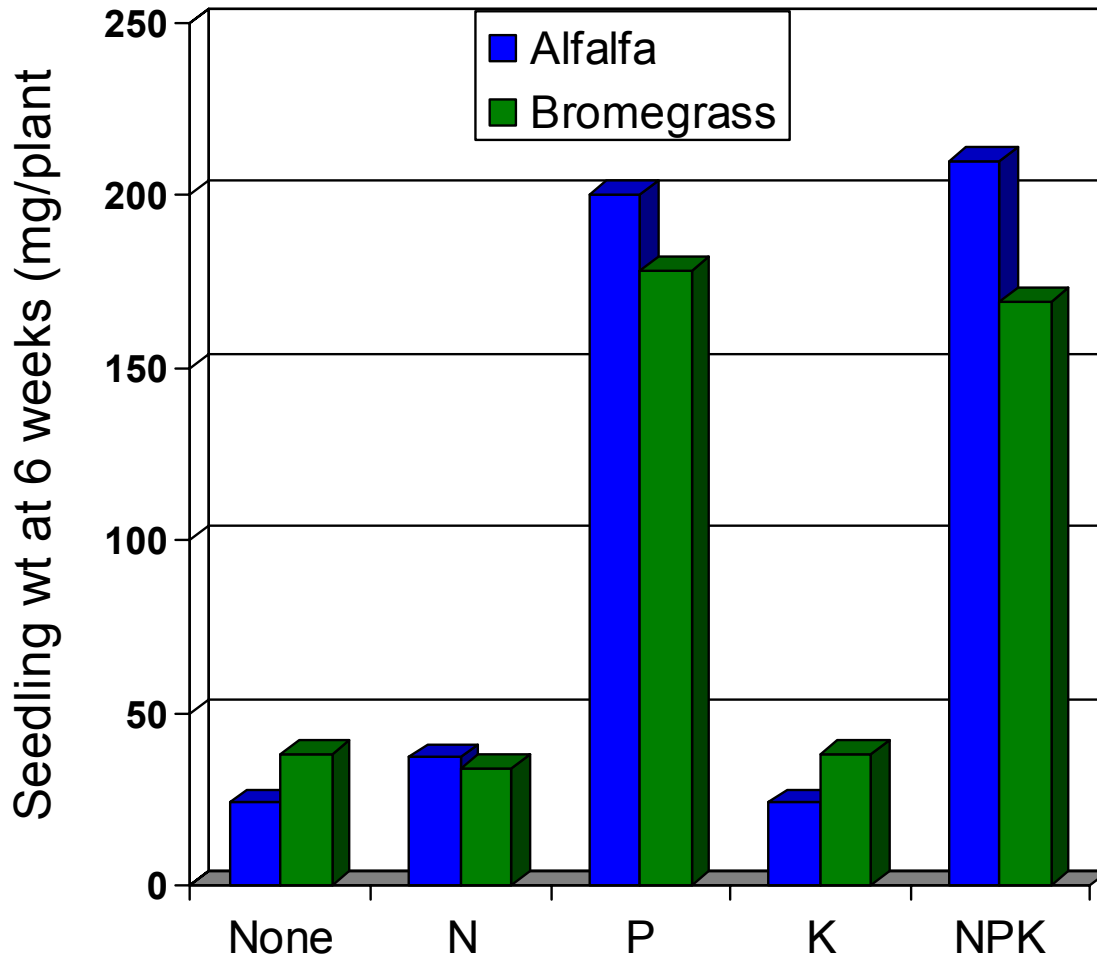
Tesar, Michigan, 1984



Banded P

Broadcast P
(Heard, OMAFRA)

Influence of Nitrogen, Phosphorus and Potassium on Seedling Vigour



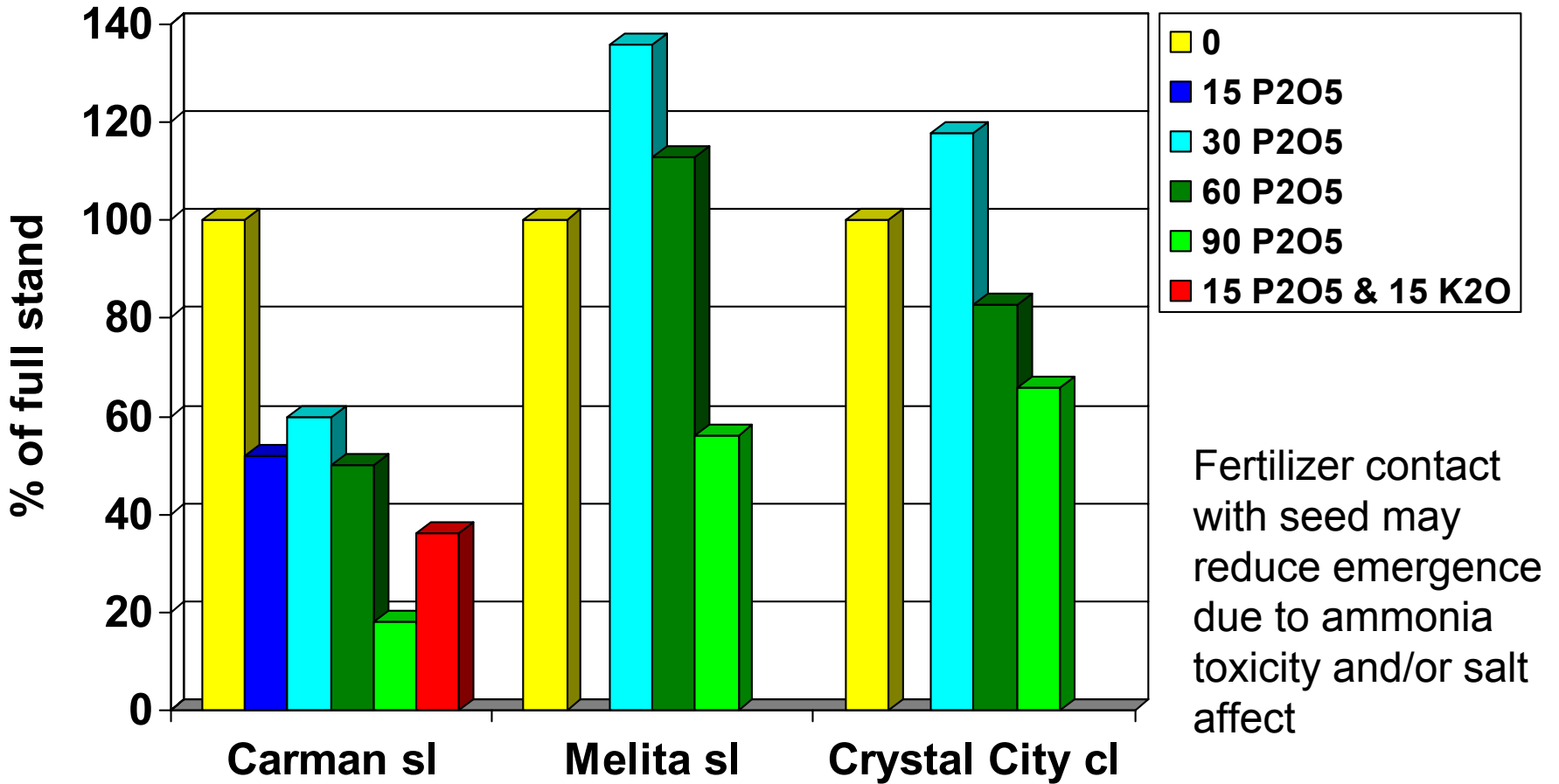
Research from as early as 1950 in Ohio showed P banded 1-2" below the seed improved growth and establishment of forages

MAFRI guide:

- 55-75 lb P₂O₅/ac for legumes
- 30-40 lb P₂O₅/ac for grasses

100 lb/ac nutrient applied
Sheard, U of Guelph, Ontario

Effect of seed-placed MAP (11-52-0) on alfalfa establishment



P Fertilizer Placement and Timing

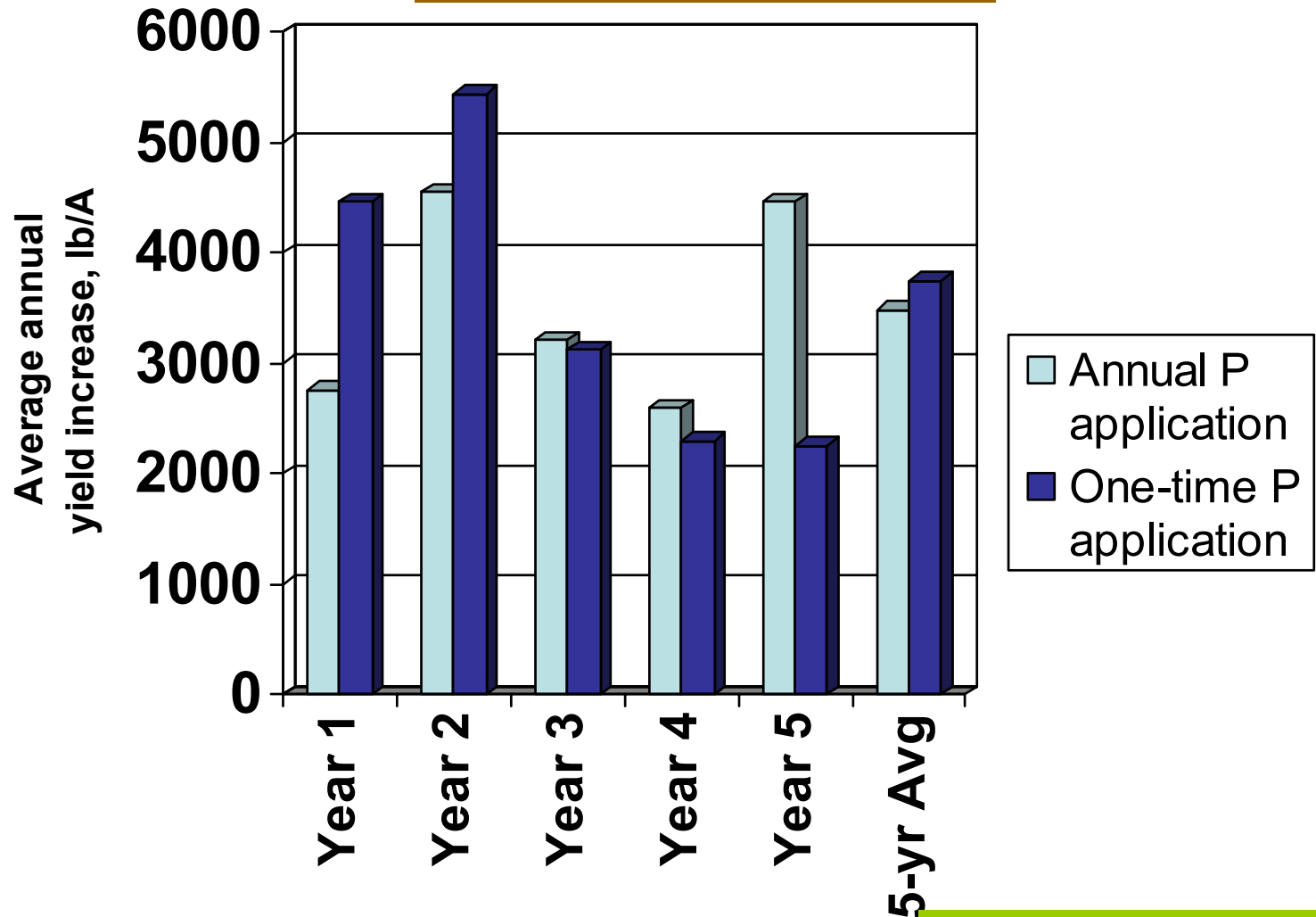
Options

- One large application vs annual applications
- Surface broadcast vs subsurface placement
- Timing – more environmental than agronomic

Influence of P Application on Increasing Alfalfa Yield (one-time application or annual application)



Broadcast application



Surface vs subsurface placement of fertilizer

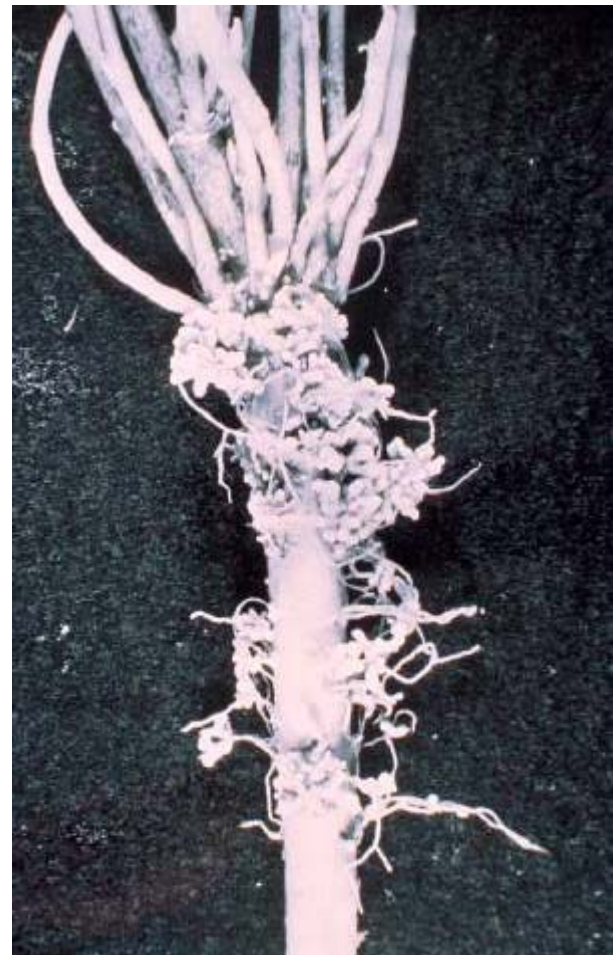
- Is there a place for banding P into the established crop?
- Experience with annual crops would suggest YES.



Forages

- very efficient surface feeders

- Root branching, density and activity are greatest at surface
- Moisture recharge for established forages usually comes from surface – so roots are active there
- Sheard (U of Guelph) - up to 30% of surface applied P used in year of application



Band Injection of fertilizer

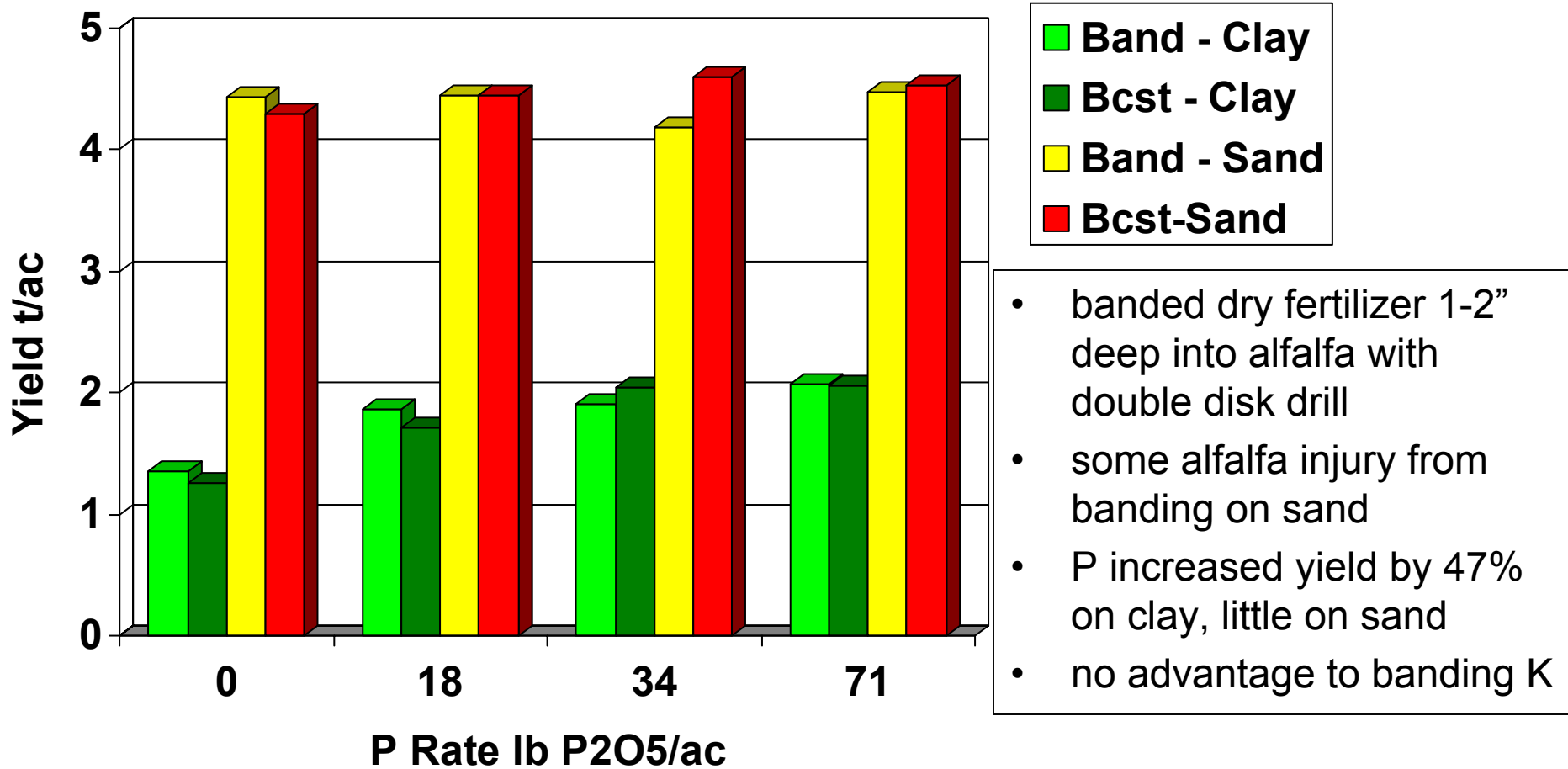
Pros

- eliminate losses to volatilization, run-off
- put nutrients into root zone, which may be an advantage under dry conditions
- reduces soil & P contact to reduce fixation
- reduce weed seedling access to nutrients

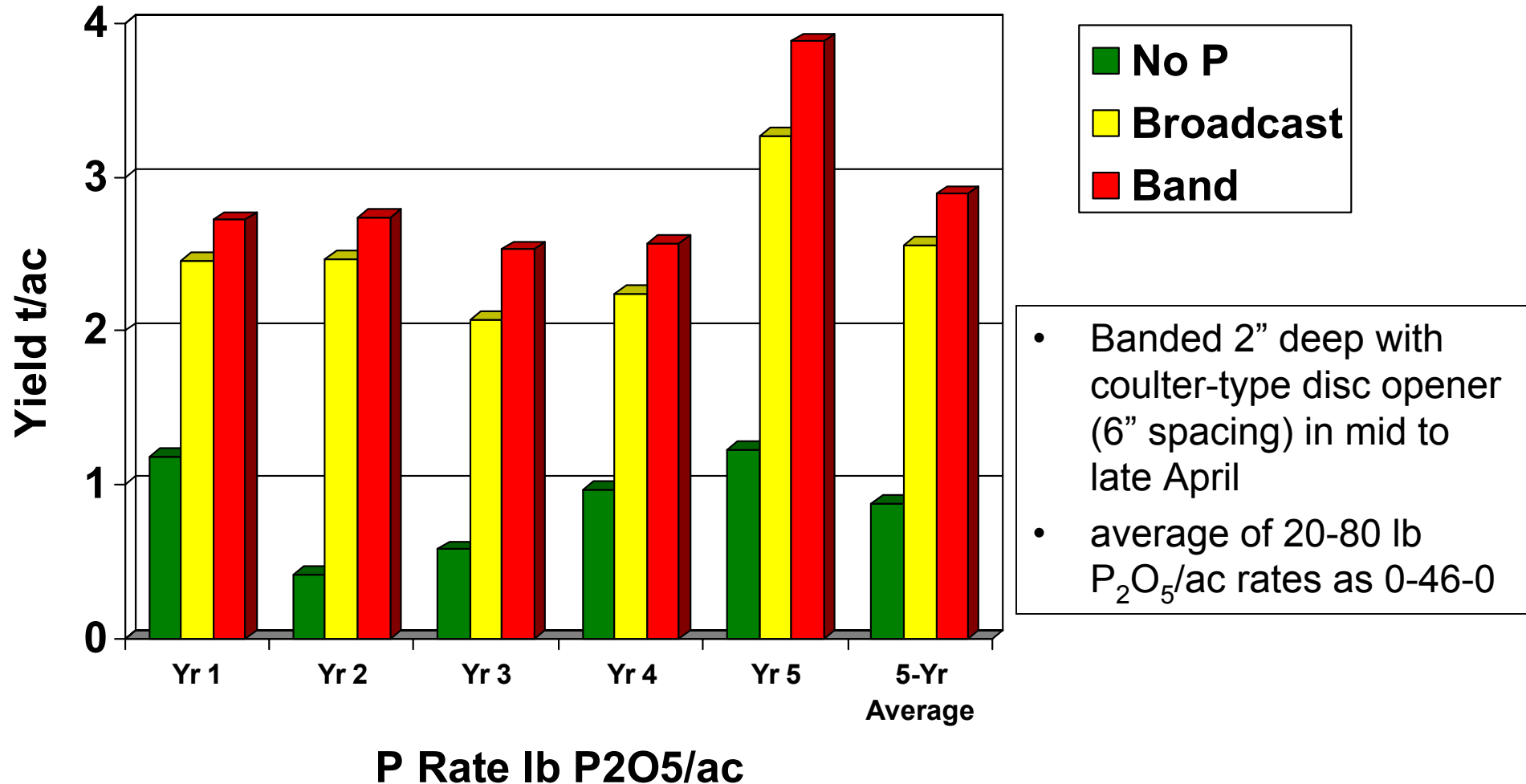
Cons

- more expensive
 - (custom rate of \$6/ac for spoke wheel vs. \$4.20/ac for surface dribble)
- slower to apply
- more costly P2O5
 - 24¢ /lb P2O5 as MAP vs 33 ¢ /lb P2O5 as 10-34-0
- potential damage to stands

Band Injection of P into Alfalfa

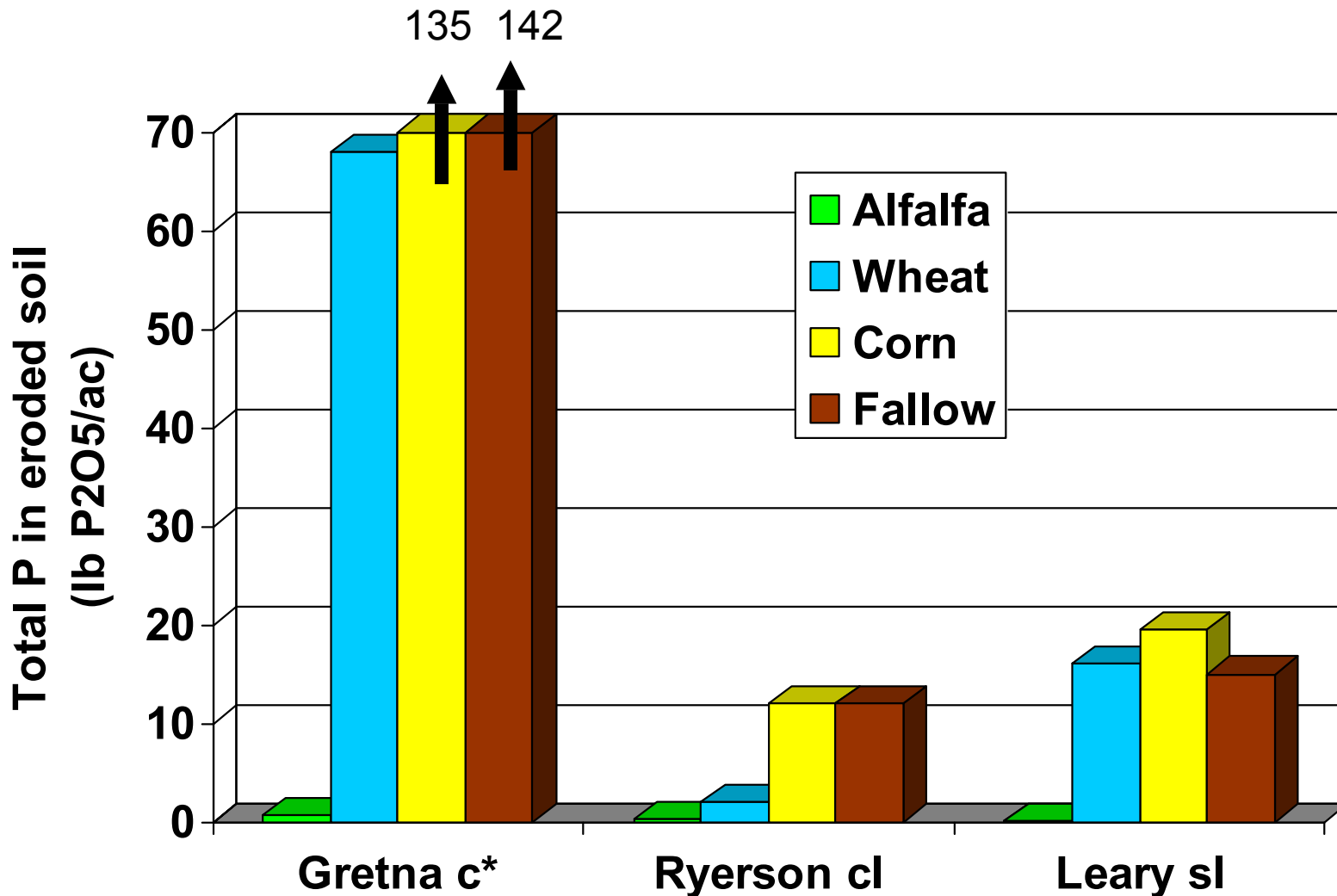


Band Injection of P into Alfalfa



Loss of P in Erosion Sediment

3 MB sites on 9% slopes, 3 yr average (1988-90)



* A single 4" rainfall event caused most of this loss

Hargrave and Shaykewich, 1991

Phosphorus, Forages and the Environment

- in MB most P is lost to surface water in snowmelt
- Considerable P comes from run-off from forage fields
- stratified or concentrated P levels at the soil surface
- unharvested forage steeps in snowmelt water and P moves away
(ie 20 lb/ac P₂O₅ in 3rd cut in slide 4&5)

P, Forages and the Environment

Management

- Soil test and apply P as required
- Subsurface P placement at seeding
- Avoid broadcast application in fall or to frozen soil (option – broadcast following 1st cut).
- Harvest fall regrowth if this does not compromise winter survival.

Diagnosis of P Deficiencies



•Visual Observation:

Distinct P deficiencies are seldom observable on alfalfa – not an effective diagnostic method!

Stand invasion by dandelions

•Soil Testing

Soil test prior to planting and regularly afterwards

•Tissue Analysis

Best way to monitor plant performance and prevent hidden hunger and yield loss

Recommended tissue concentration:
0.25 to 0.40% P in top third of plant



Potassium (K)

Adequate K improves:

Plant persistence

Number of shoots per plant

Shoot yield

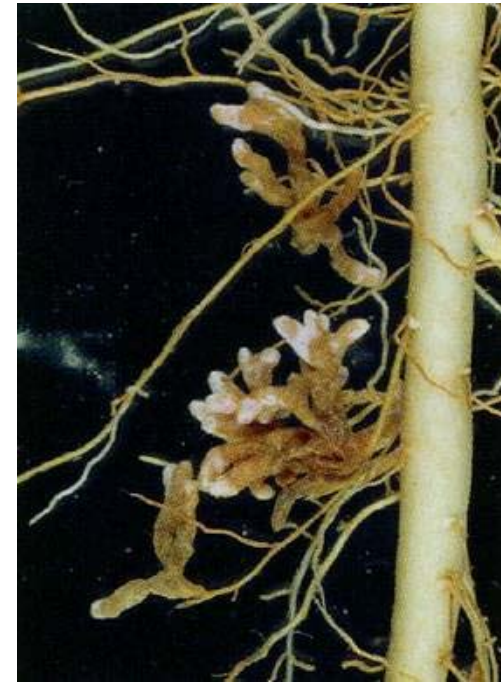
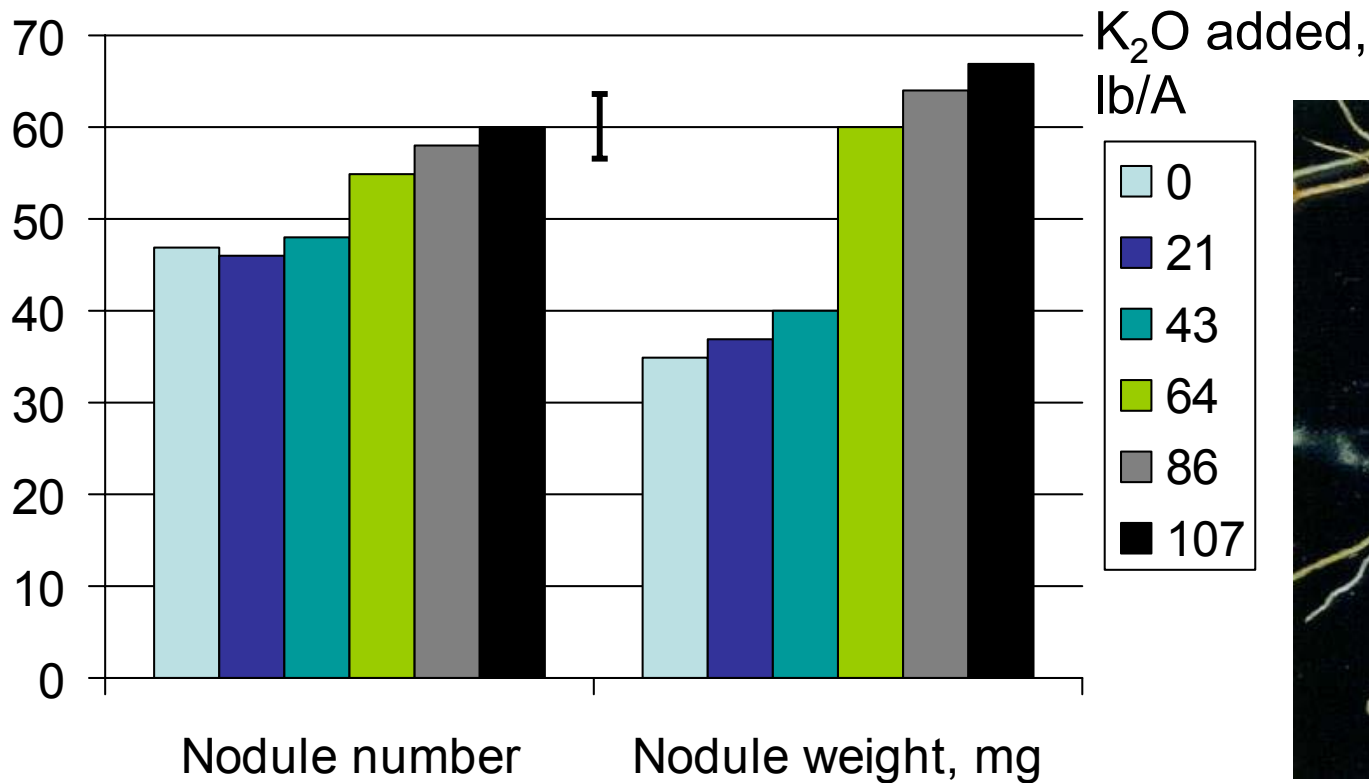
Deficient K reduces root starch storage

Reduces protein concentration in root

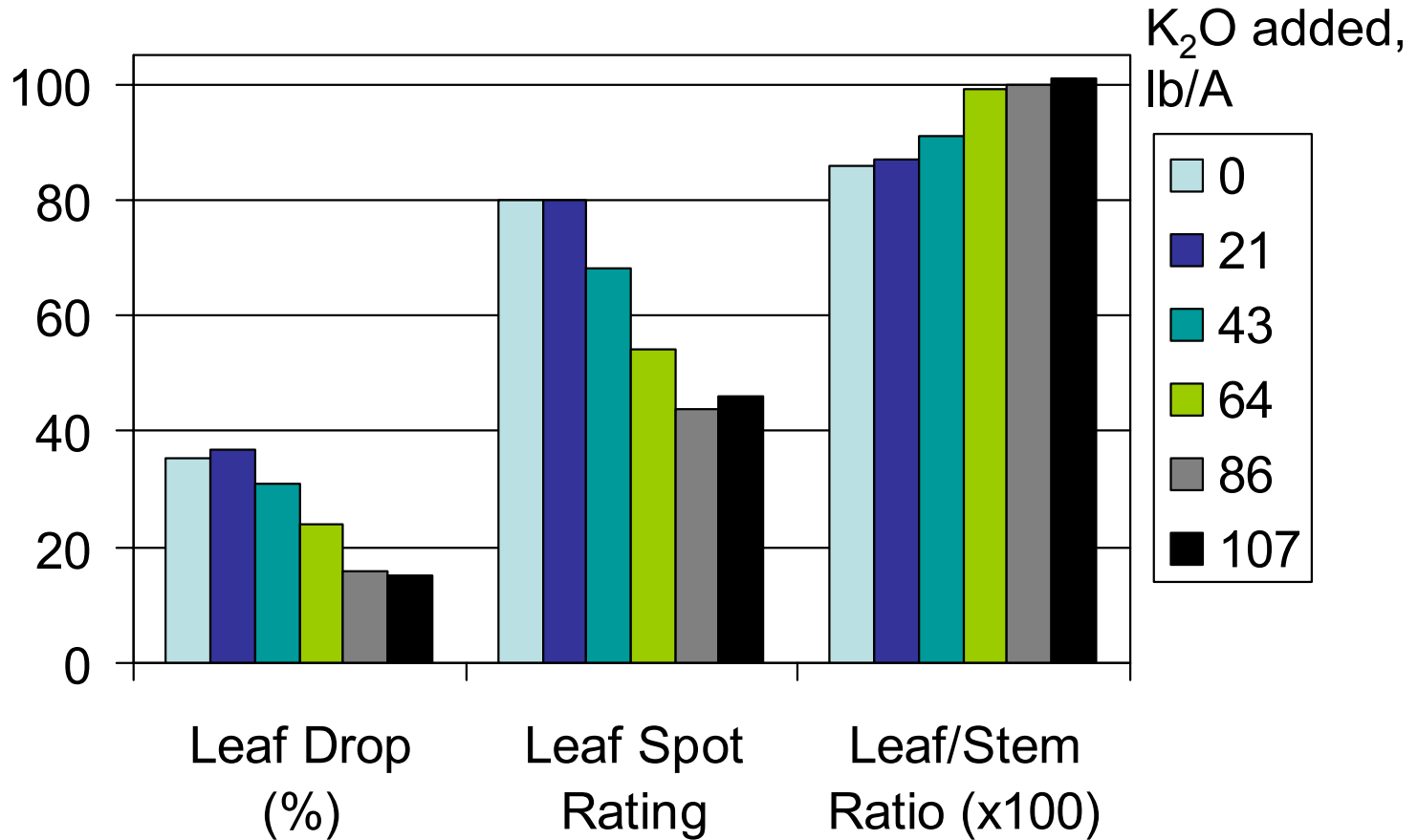
Results in poor survival and slow shoot growth



K Fertilization Increases Nodule Activity

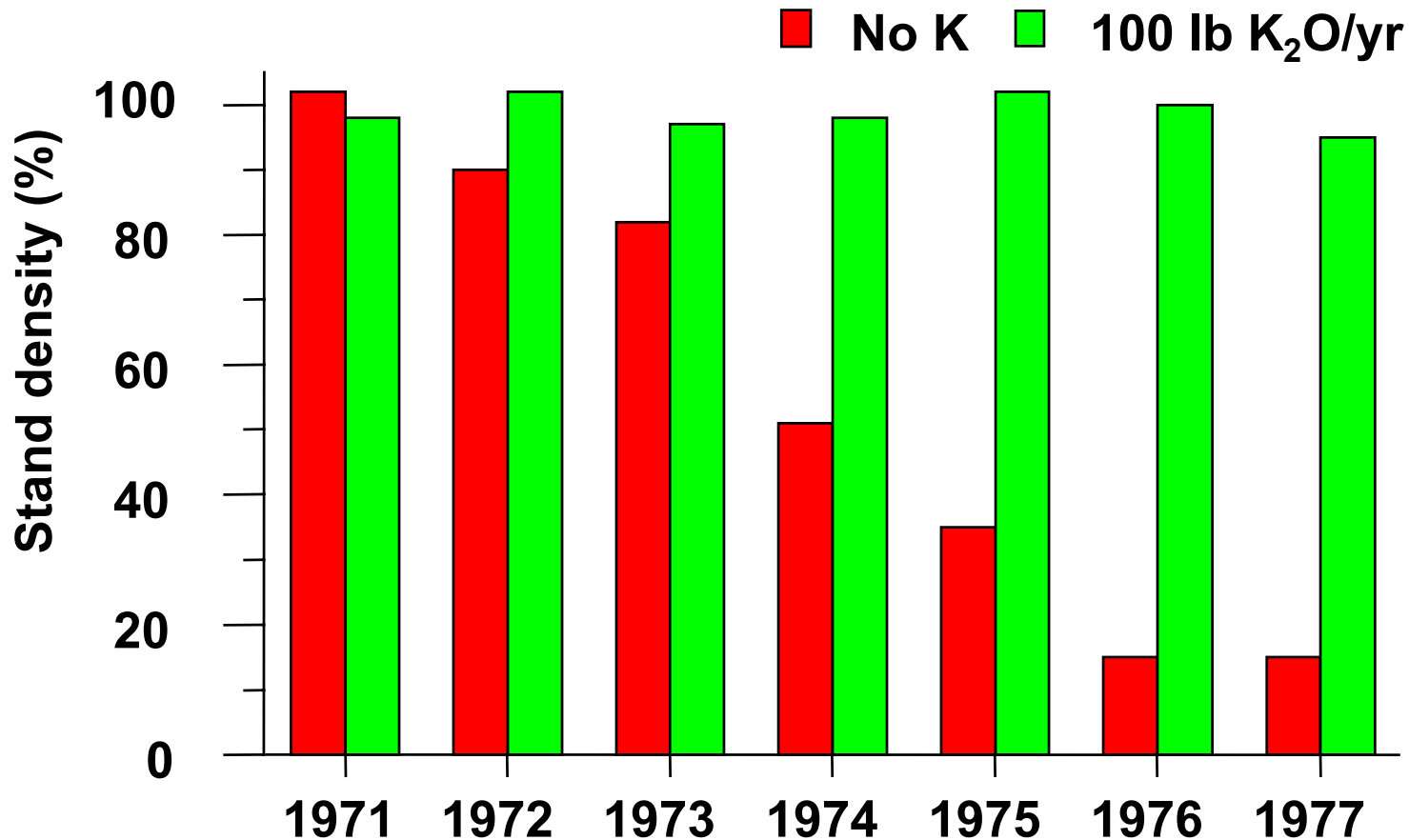


K Fertilization Improves Hay Quality



K Helps Reduce Winterkill in Alfalfa

Plant counts taken in May as % of those previous September

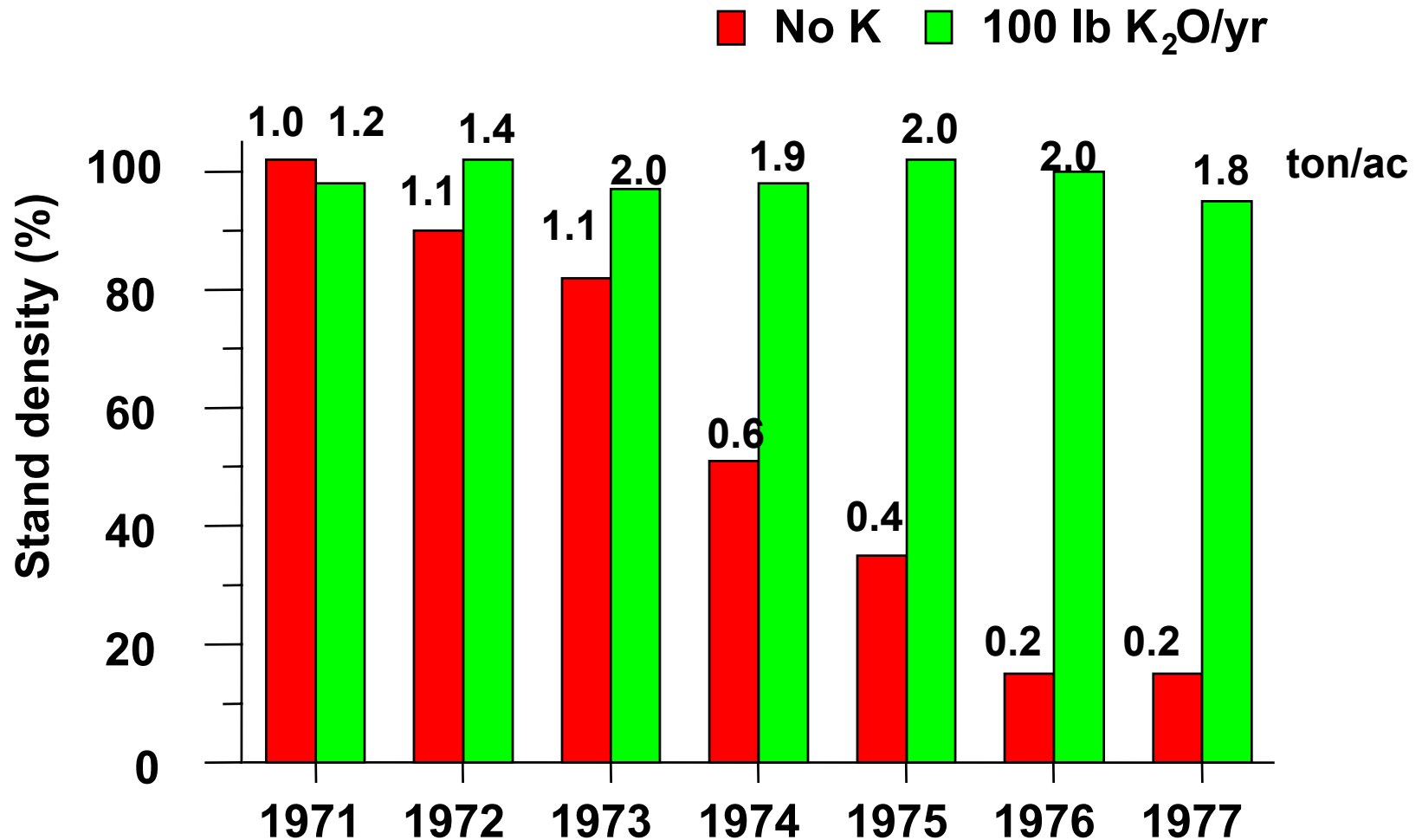


Sandy loam soil
Initial soil K = 116 ppm

Year

Bailey, 1983 (MB)

K Helps Reduce Winterkill in Alfalfa

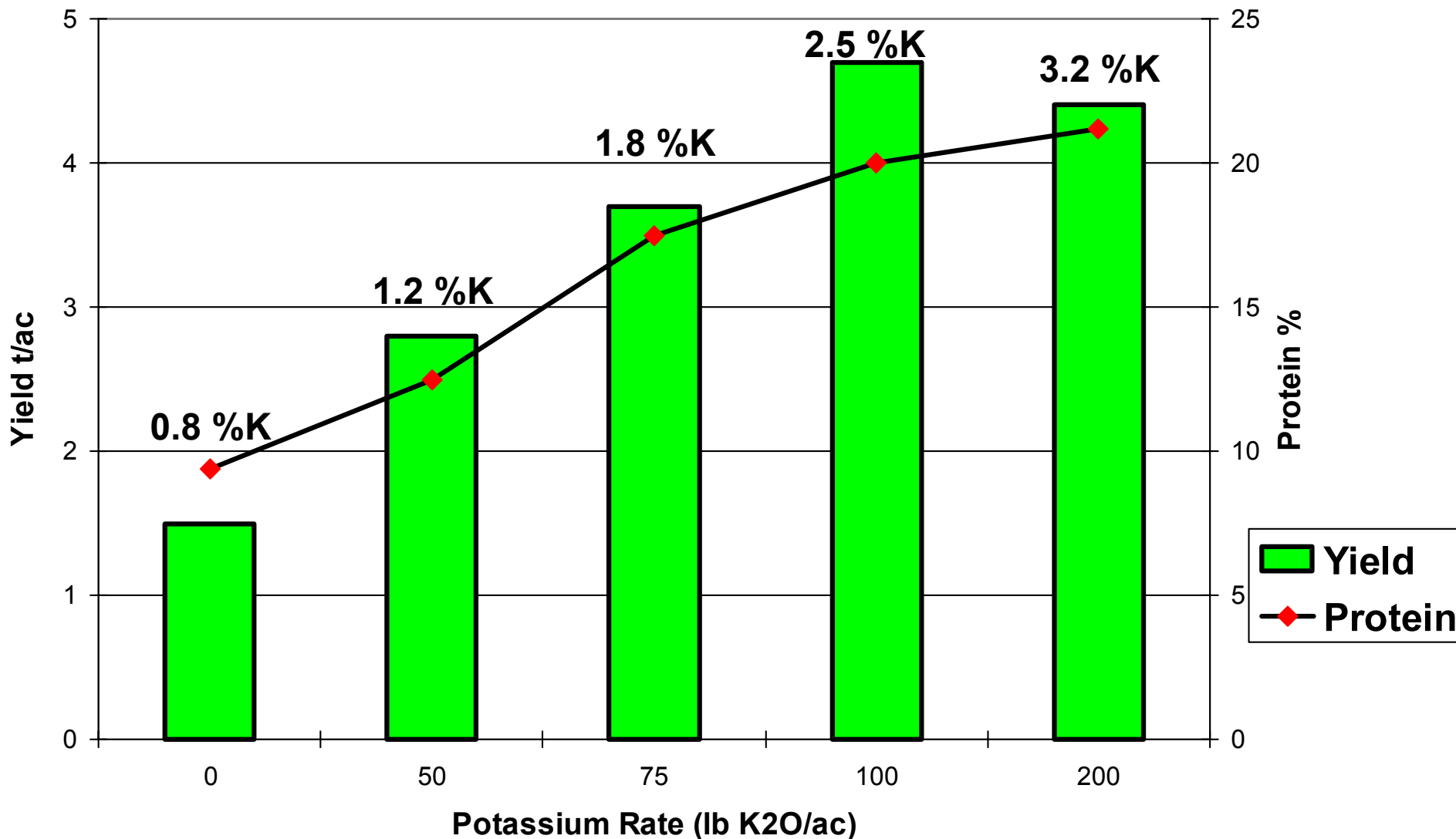


Sandy loam soil
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Bailey, 1983 (MB)

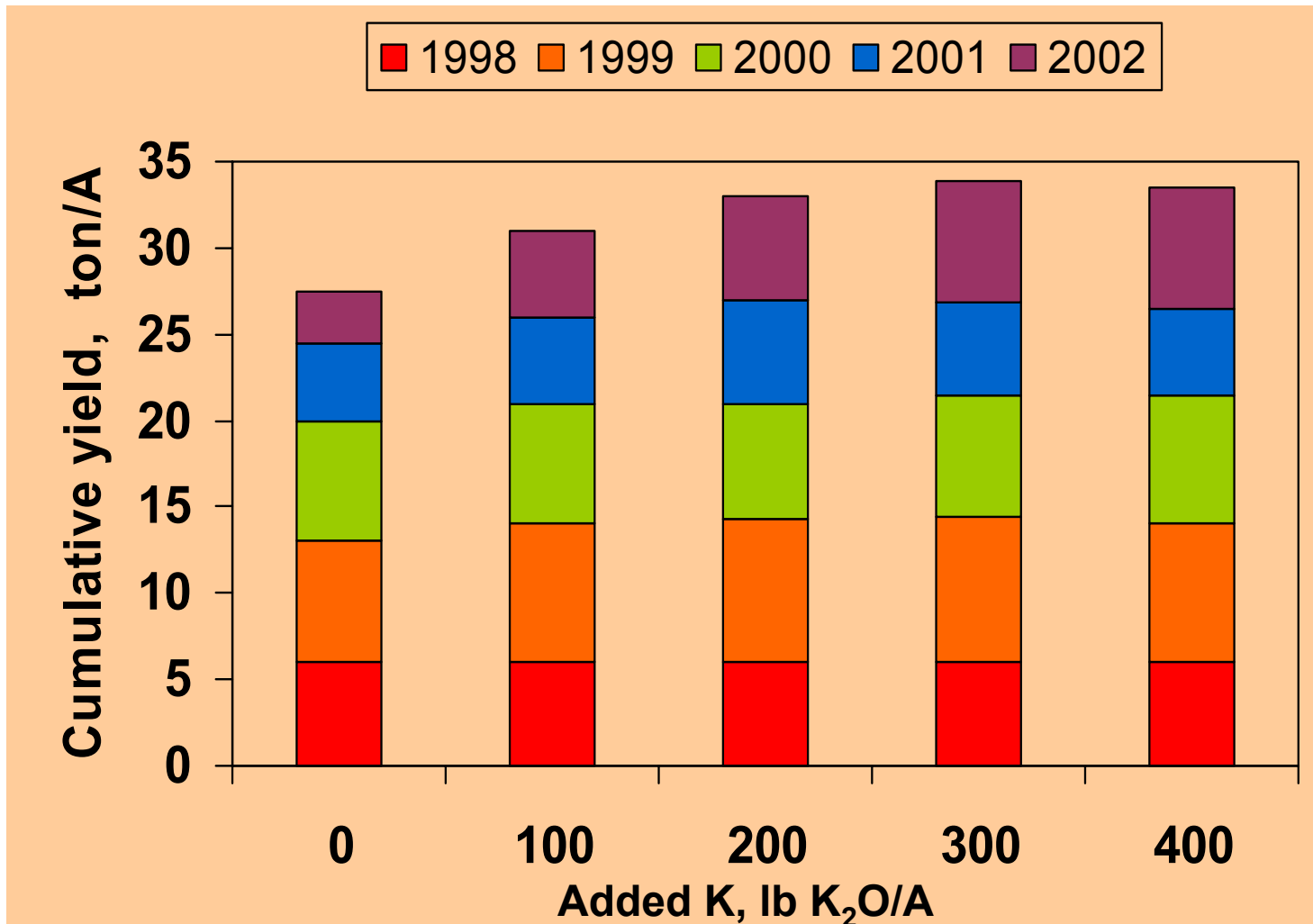
Effect of K on Alfalfa Yield, Protein and K Content



5 station years on 3 MB soils.

Initial soil K = 14-180 ppm. Plots fertilized annually with 60 lb P₂O₅/ac and 30 lb S/ac.

Response to K Increases Over Life of Stand



Greatest response occurred in 5th year

Placement and Application Options

- Establishment

- Broadcast to build up soil test K before seeding
- Banded starters should contain mostly P

- Maintenance

- Apply following harvest to replace removal
- High rates: split over several cuts to avoid salt injury
- To boost winter hardiness, apply before critical fall growth period (before last 6 weeks of growth)
- When soil K levels are high, spring applications can lead to higher K levels than desired, and may be unnecessary

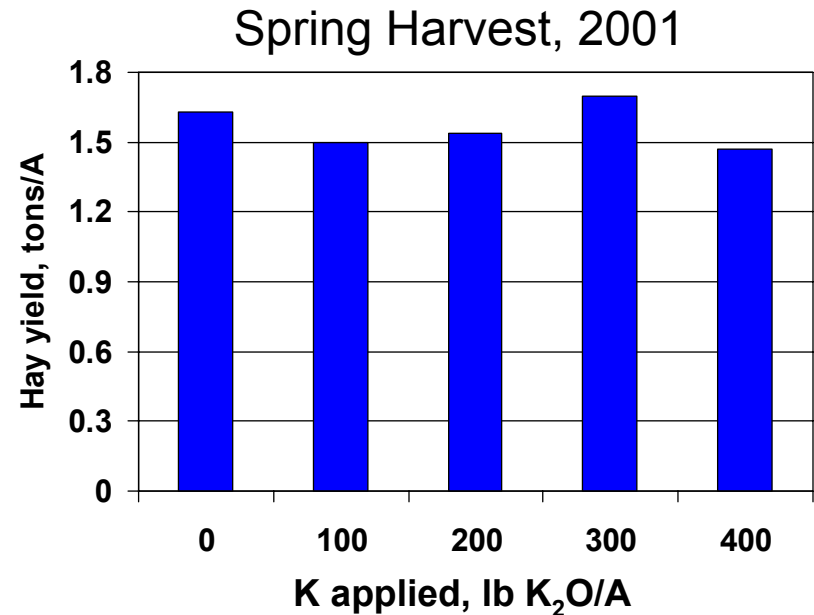
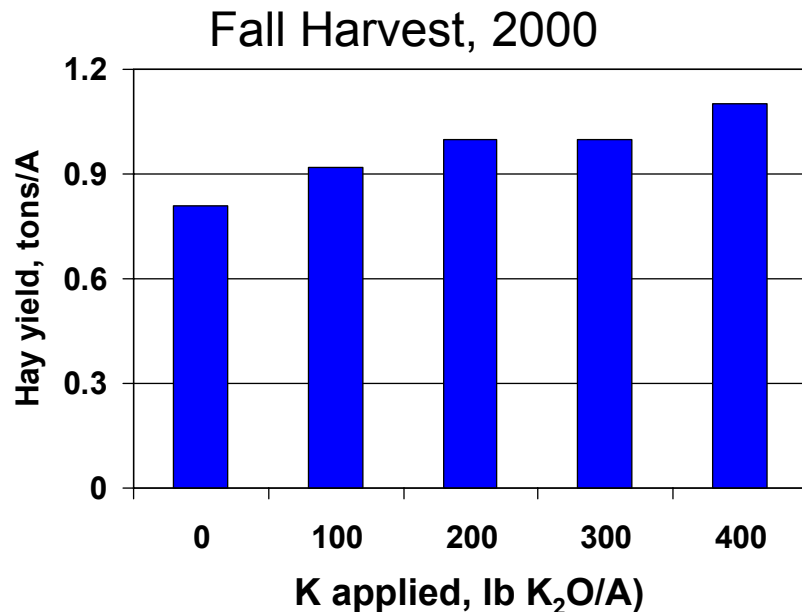
Recovery of K from Various Soil Depths

Depth of placement, in.	Recovery, % of applied
Surface	41
0-6	29
6-12	19
12-18	16
18-24	10
30-36	11



Recovery at the end of the growing season with K placed in the Spring at various depths in an established alfalfa stand

K Impacts Fall Harvest more than Spring

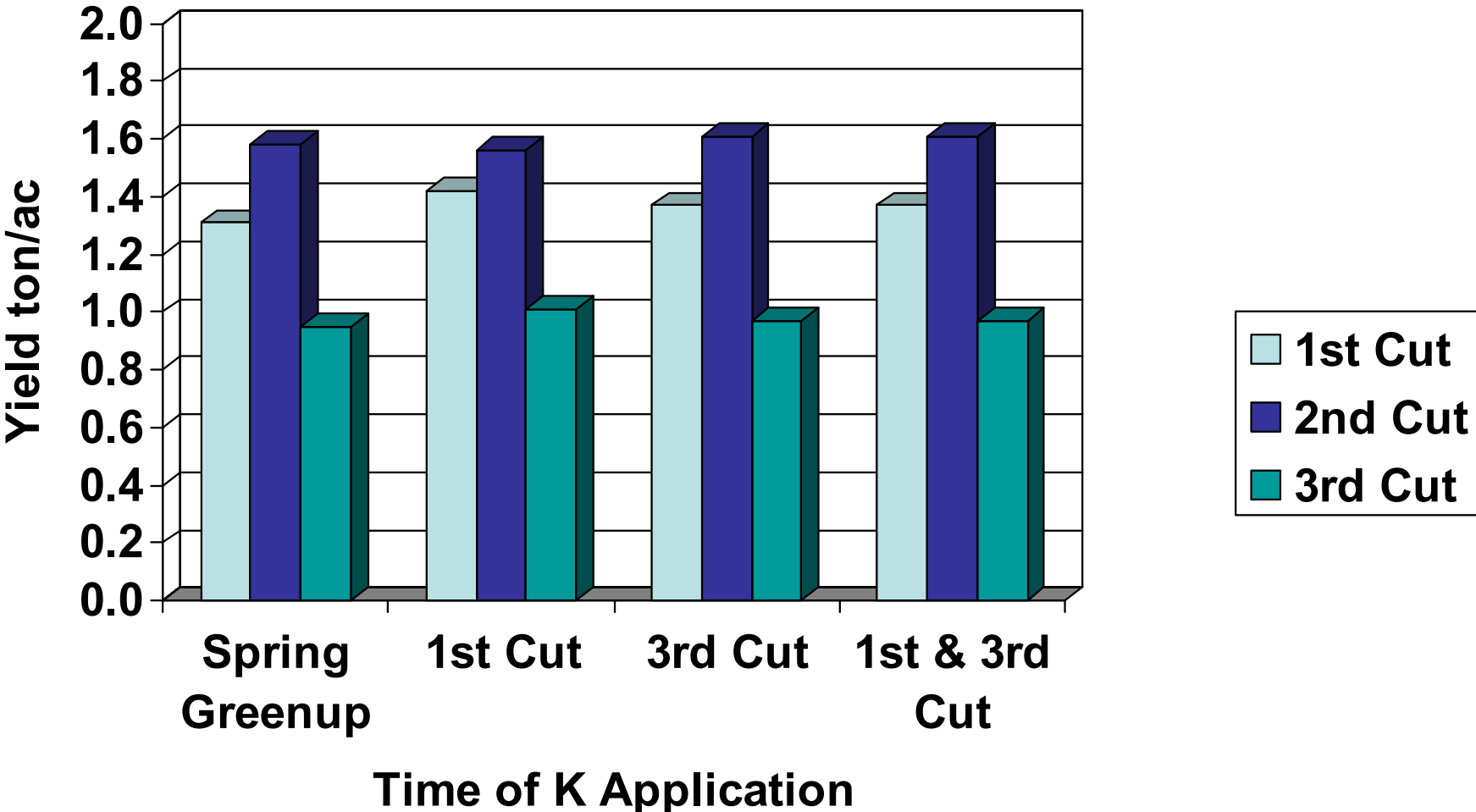


Yield response to K found in last harvest of 2000.

For first harvest of 2001, no response to K fertilization was observed

Reason: K can be released from soil minerals during winter and spring

Effect of K timing on alfalfa yield by cutting



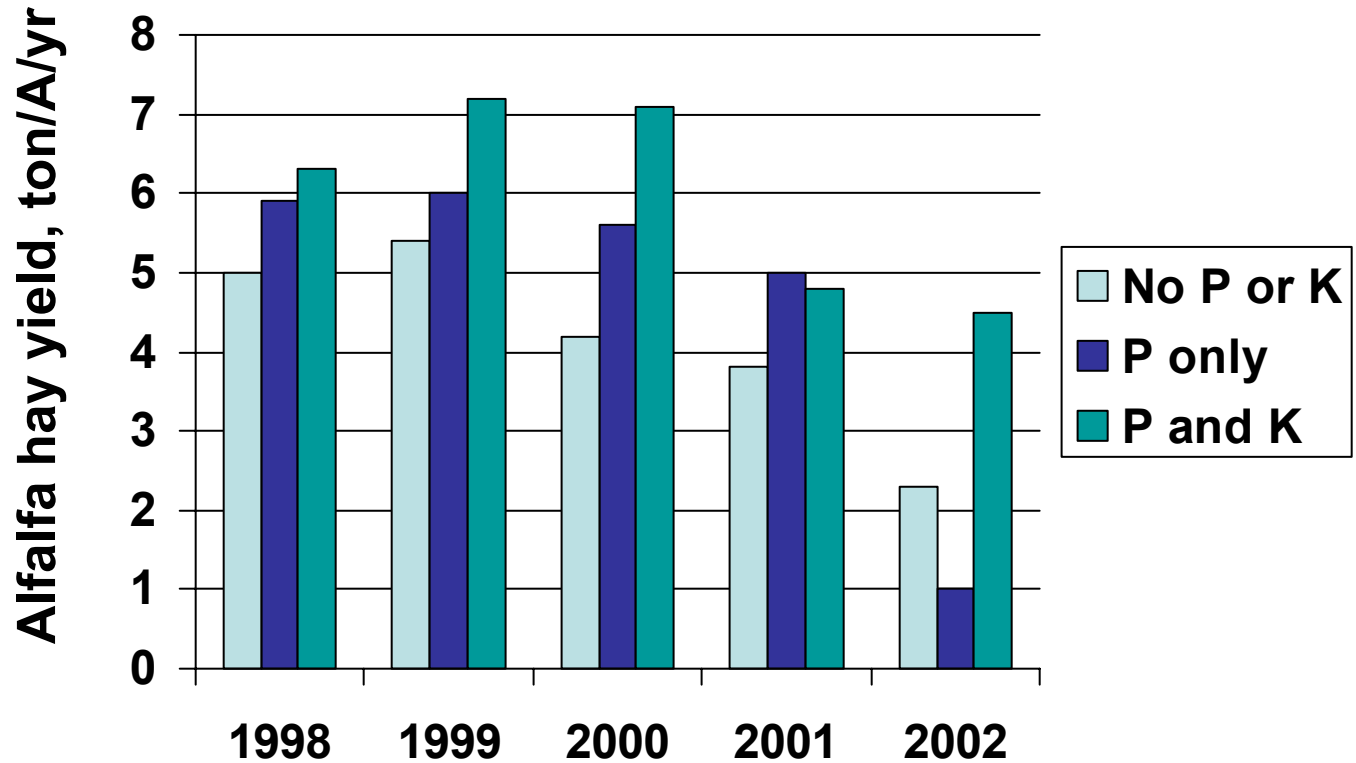
Considerations – availability of time, equipment, injury to stand of trafficking

Luxury Uptake of K for Dairy Feed

- K in alfalfa varies from $<1.5\%$ to $>3\%$
 - Luxury uptake when soil K is very high
 - K levels above 3% unnecessary
 - Liquid manure systems efficiently recycle K
- High K forage: A concern for dry dairy cows
 - Leads to milk fever, retained placentas after calving
 - For the transition period (2 to 4 weeks before calving) forage with $<2\%$ K desired; dietary K should be $<1.2\%$
 - Corn silage, grains, distillers grains are low K feeds
 - Anionic salts (chlorides or sulfates of NH_4^+ , Mg, or Ca) can help correct the problem

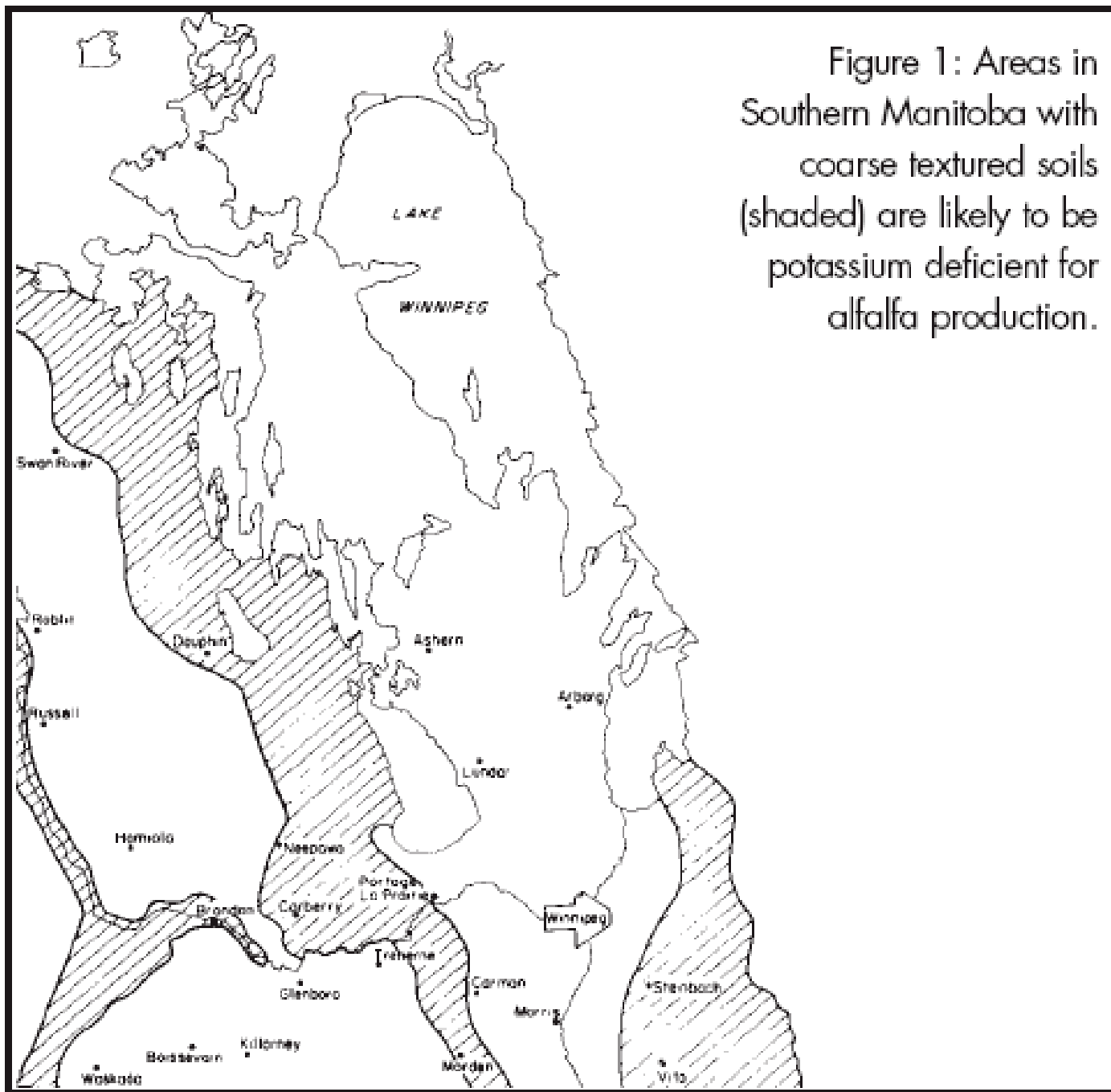


Balanced P and K Nutrition Is Essential for Optimal Yields and Stand Maintenance



Soil Testing and Plant Analysis

- Soil Testing
 - Verify that K levels are being maintained
 - Soil pH 6.5 or higher for efficient N fixation
- Plant Analysis
 - Usually sample the top 6 in. at harvest
 - Indication of adequate K fertility:
 - <2% indicates insufficient K for winter hardiness
 - Optimum yields usually contain around 2.5% K
- Visual symptoms



Soil testing will indicate the presence of low K soils.

High yields of forages will deplete soils quicker than other crops and this should be monitored through soil sampling.

Potassium deficiency

- sandy, well drained soils
- peat soils
- Visual deficiency symptoms
- Thinner stands
- Whitish spots on leaf margins





moderate K deficiency



severe K deficiency



Sulphur deficiency in Forages

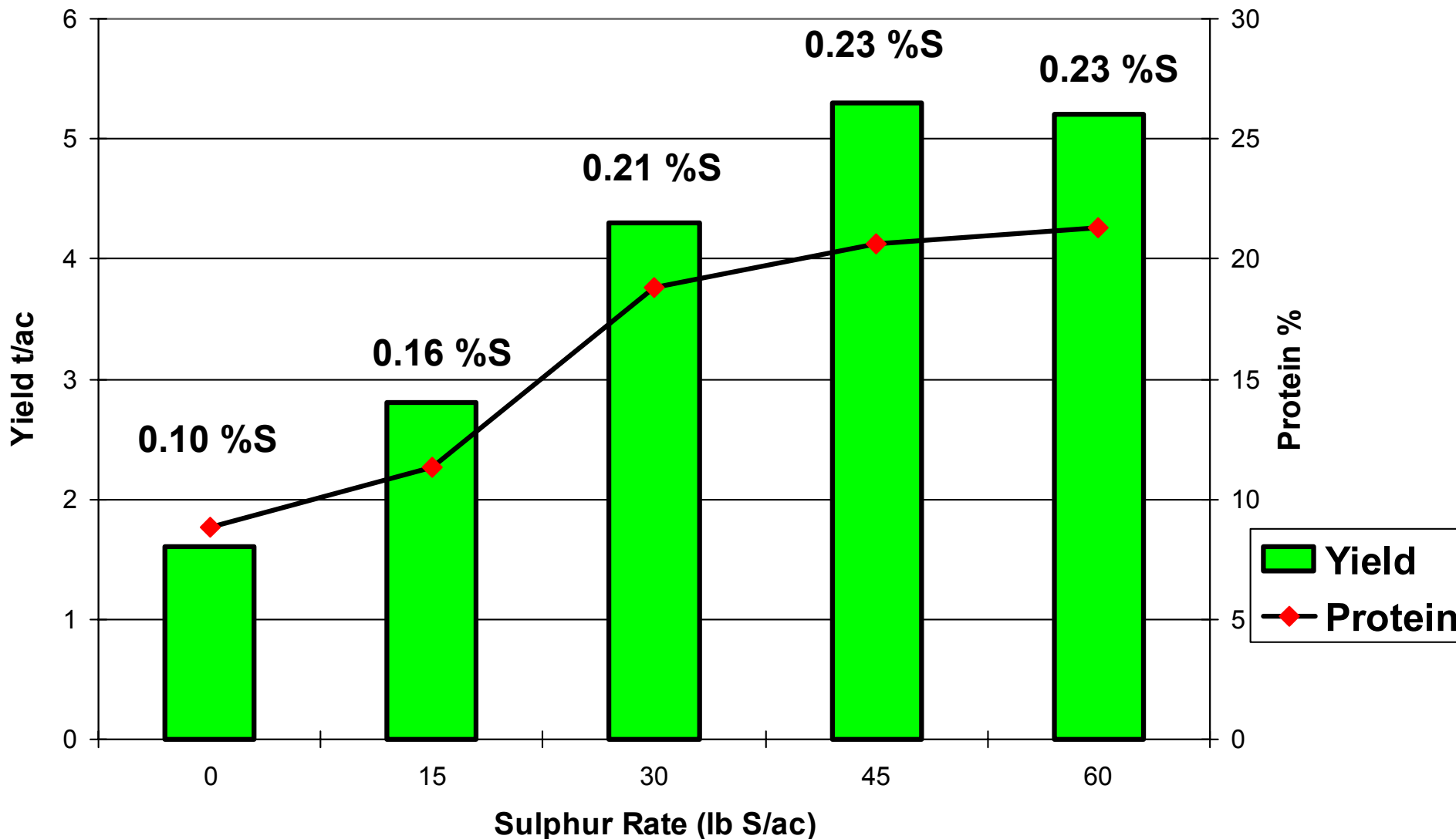
- well drained soil
- grey wooded soil
- high removal crops

Deficiencies

- light green colour
- like N deficiency
- lower protein
- patchy patterns



Effect of S on Alfalfa Yield, Protein and S Content



5 station years on a Grey Wooded soil in MB.

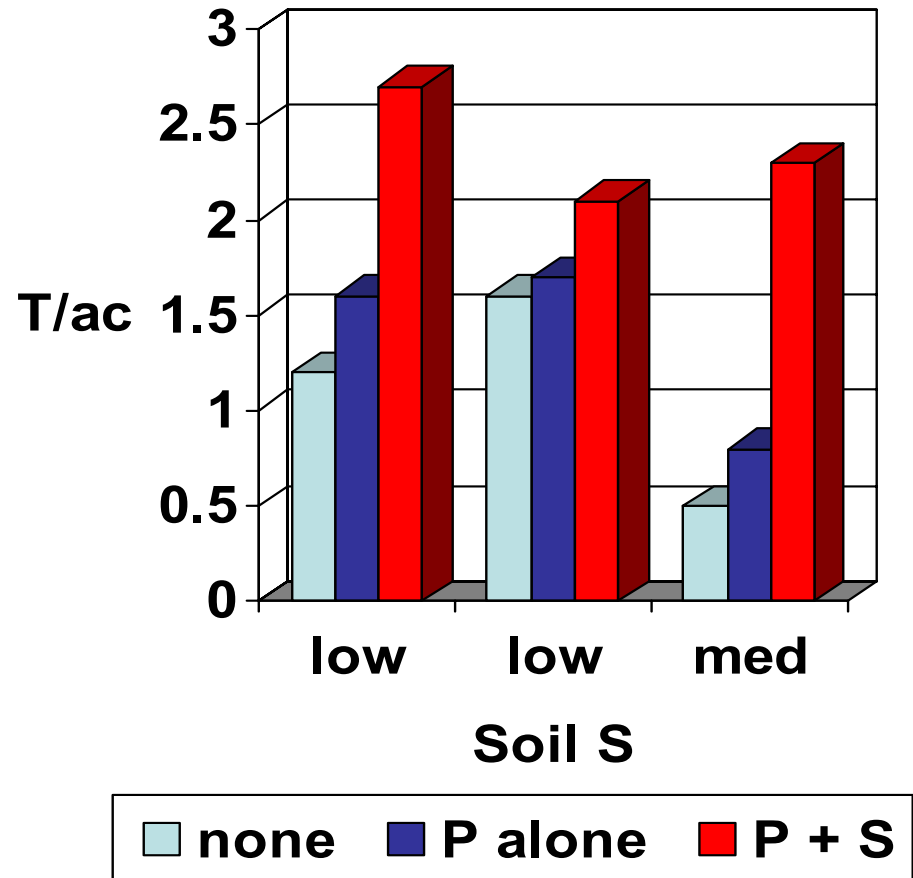
Initial soil S = 13 lb/ac. Plots fertilized annually with 60 lb P₂O₅/ac and 30 lb K₂O/ac.

S Fertility of Alfalfa

- rates are 25-30 lb S/ac

S fertilizer options

- 21-0-0-24S
- 12-0-0-26S liquid
- elemental S
- gypsum 13%S



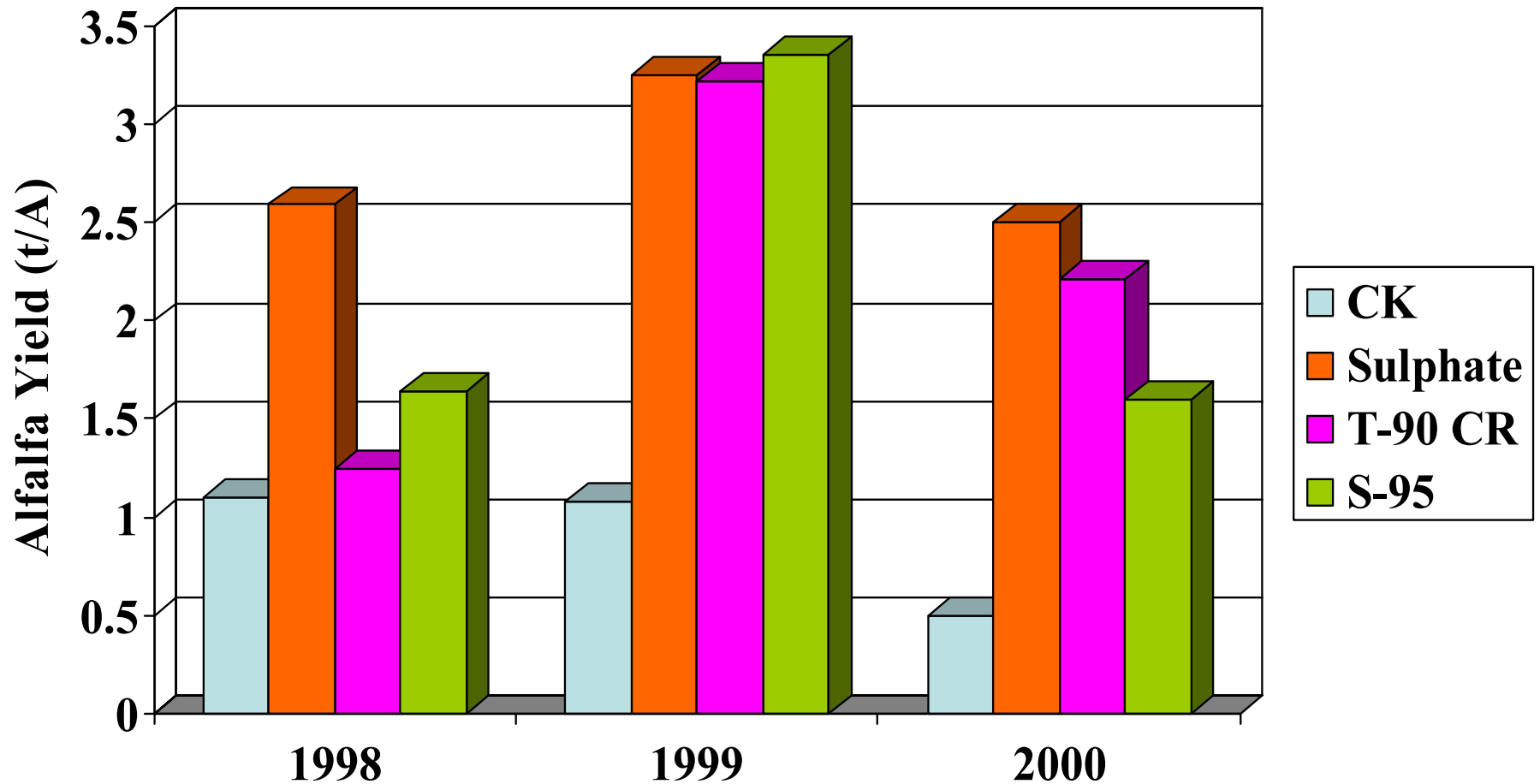
Sulphur For Forages

A fit for elemental products . . .



- Elemental products oxidize to sulphate forms more rapidly when surface applied and left exposed for weathering.
- Forage legumes do not benefit from the nitrogen supplied in other forms of sulphur – such as ammonium sulphate (21-0-0-24S)

Alfalfa Yield Response to S Application Westco

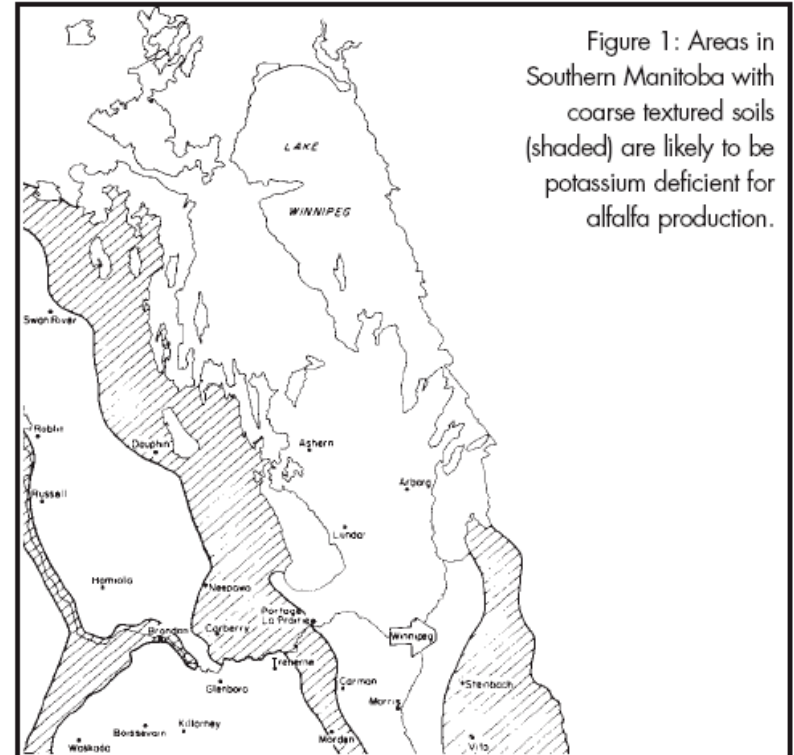


S surface broadcast applied at 50 lb/A once in spring 1998

Boron for alfalfa

A micronutrient:

- 0.8 lb B/ac removed with 4t/ac
- Often is supplied by mineralization of soil organic matter, crop residues



Deficient soils

- high pH
- sandy texture
- low organic matter
- “DRY WEATHER DISEASE”

Boron for alfalfa

Visual signs

- stunted regrowth
- yellow-purplish tips
- reduced flowering

Tissue test < 20 ppm B

Soil test < 0.3 ppm

Apply

- 1-2 lb B/ac to soil or
0.2-0.5 lb B/ac foliar



Manure Management

- Manure supplies many nutrients
 - ...but usually not in the ratio required for alfalfa!**
- Physical problems
 - compaction, crown damage, leaf burn, salinity
- Nutritional problems
 - N can stimulate weeds
 - excessive K can cause cation imbalance in dairy feed rations



Forage fertility summary

- Soil test
(p 40-41 SFG)
- tissue test
(p 26 SFG)
(feed analyses
if necessary)
- respect forages
for the nutrients they **NEED** and **REMOVE**



References

Potash and Phosphate Institute

- P Nutrition of Alfalfa
- K Nutrition of Alfalfa

Westco

Forage Fertility – Are You Maximizing Yields?

MAFRI

- Fertilizing Alfalfa Forage factsheet