General Information

- 5 K treatments (0, 100, 200, 300, 400 lbs. K$_2$O/acre/year)
- 4 P treatments (0, 50, 100, 150 lbs. P$_2$O$_5$/acre/year)
- We apply half the specified amount of fertilizer after the first forage harvest and the remainder after the last forage harvest
- Initial Soil Test Levels: 80-100 mg K/kg and 5-10 mg P/kg
- We harvest 4 times annually for yield, mass/shoot, and shoots/area
- We dig roots in May and December to determine plant population
- We soil sample (0-2, 2-4, 4-6, and 6-8 inch depths) after each harvest and in spring after the plants break dormancy
Questions We Will Address

- How does P and K fertilization impact long-term yield?
- What plant factors are most closely associated with yield?
- When should soils be sampled?
- When should fertilizer be applied?
- Are there critical tissue test levels?
Control plot yield has declined steadily since 1999.
The 400 K\textsubscript{2}O/ 0 P\textsubscript{2}O\textsubscript{5} treatment did not really increase yield until 2002 and 2003.
Yield increased with the 0 K\textsubscript{2}O/ 150 P\textsubscript{2}O\textsubscript{5} treatment from 1998 to 2000, but resulted in lower yields than the control plots in 2002 and 2003.
With 400 K$_2$O/ 150 P$_2$O$_5$, yield increased from 1998 to 2000, and in 2002 and 2003 yields were twice those of the control plots.
Yield component analysis permits us to better understand how alfalfa responds to phosphorus and potassium fertilization.

\[ \text{Yield} = \frac{\text{plants}}{\text{area}} \times \frac{\text{shoots}}{\text{plant}} \times \frac{\text{mass}}{\text{shoot}} \]
Plant population declined for all fertility treatments, and was not closely associated with forage yield.
Plants Disappear During Summer!

Summer Plant Disappearance

Plant Population, plants/m²

- P

+ P

Dec 97  May 98  Dec 98  May 99  Dec 99  May 00  Mar 01  May 01  Dec 01  May 02  Dec 02  May 03

0  100  200  300  400  500
Shoots per square foot was not closely associated with forage yield.
Mass per shoot was most closely associated with forage yield.
Bigger Plants with P and K

Low K and P

High K and P
400 $K_2O/150 \, P_2O_5$

0 $K_2O/0 \, P_2O_5$
Phosphorus fertilization increased soil test P levels in all K treatments.

Soil Test Phosphorus (mg P/kg)

- 0K/0P
- 200K/0P
- 400K/0P
- 0K/150P
- 200K/150P
- 400K/150P

Depth, cm
Soil Test K Increased Between September and March Without K Application

- 0 K₂O Applied
- 100 K₂O Applied
- 200 K₂O Applied
- 300 K₂O Applied
- 400 K₂O Applied

Mehlich III Soil Test K (mg/kg)
Critical Tissue P Concentration?

Phosphorus Concentration, mg P/g tissue

Yield, % of maximum yield

Phosphorus Concentration, mg P/g tissue
Critical K Concentration?
(Harvest 1)
Critical K Concentration? (Harvest 4)

Yield, % of maximum

Concentration, % K
Answers To Our Questions

- How does P and K fertilization impact long-term yield?
  - Generate larger plants that make bigger shoots
- What plant factor is most closely associated with yield?
  - Mass per shoot
Answers To Our Questions

➤ When should soils be sampled?
➤ **Fall is better, but be consistent**
➤ When should fertilizer be applied?
➤ **50% after first harvest and balance possibly after last harvest**
➤ Are there critical tissue test levels?
➤ **Yes, but we are not sure what they are yet**
Stand Survival and Yields are Poor When K-Stressed Alfalfa is Fertilized with P Alone
Severe stand losses have occurred where P has been applied without K.

Control plot regrowth rates are slower and have led to significant weed infestation and yield reductions.
May 19 2003: First Hay Harvest

100 K$_2$O/150 P$_2$O$_5$

400 K$_2$O/50 P$_2$O$_5$

0 K$_2$O/50 P$_2$O$_5$

300 K$_2$O/100 P$_2$O$_5$

0 K$_2$O/100 P$_2$O$_5$
Questions?