



# Developing Practical Phosphorus and Potassium Tissue Test Recommendations and Utilizing Struvite in Modern Alfalfa Systems II

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## OBJECTIVES

Develop and calibrate phosphorus ( $P_2O_5$ ) & potassium ( $K_2O$ ) nutrient recommendations for bud stage alfalfa using tissue testing for maximum profit, yield and direct comparison to current soil testing recommendations.

Compare efficacy of combinations of monoammonium phosphate (MAP) and struvite (magnesium ammonium phosphate,  $MgNH_4PO_4 \cdot 6 H_2O$ ) for fertilization of alfalfa.

Evaluate quality of hay samples at different  $P_2O_5$  and  $K_2O$  rates and tissue concentrations.

## STUDY DESCRIPTION

### Plot Layout:

Three alfalfa research studies (P Study, K Study, and Struvite Study) were grown near Prosser, WA in South Central WA, in a low P & K testing soil.

### P Study:

Differing rates of  $P_2O_5$  using MAP; including: 0, 30, 60, 120, 240 lbs/acre.

### K Study:

Differing rates of  $K_2O$  using potassium sulfate: 0, 40, 80, 160, 240, 320 lbs  $K_2O$ /acre

### Struvite Study:

Application of 144 lbs of  $P_2O_5$ /acre in differing ratios of MAP:Struvite in alfalfa including: 100:0, 75:25, 50:50, 37.5:62.5, 25:75, 12.5:87.5, 0:100 and an unfertilized check.

### Analysis:

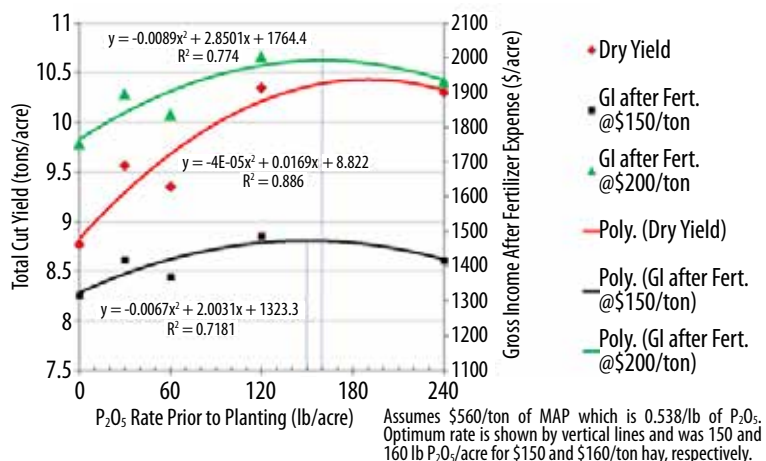
Dry matter analyzed for yield, P or K content (ICP method), hay quality (NIRS method).

**Table 1.** Optimal percent phosphorus in harvested alfalfa hay to maximize alfalfa gross income after fertilizer expense by cutting and seasonal average at two hay prices.

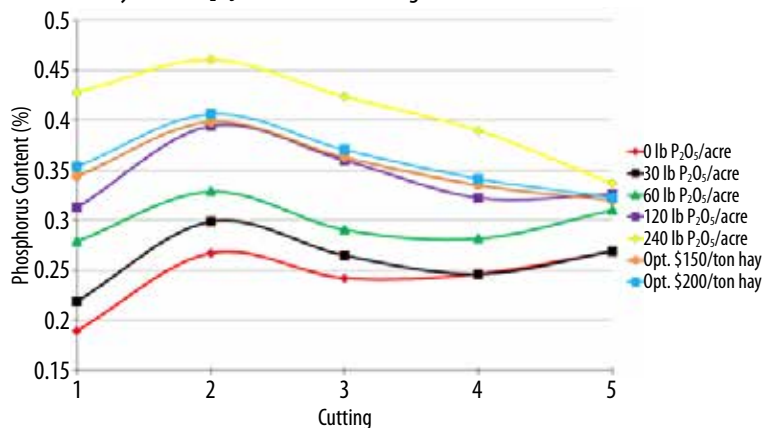
Hay Price	Optimum P Averaged over Cuttings (%)	Optimal % P in Harvested Hay to Maximize Alfalfa Gross Income After Fertilizer Expense				
		-----Cutting of Hay-----				
\$/Ton	Avg. P (%)	First	Second	Third	Fourth	Fifth
150	0.35	0.34	0.40	0.36	0.34	0.32
200	0.36	0.35	0.41	0.37	0.34	0.32

## RESULTS – P STUDY

**Figure 1a.** Rate of  $P_2O_5$ /acre influence on total yield and gross income after fertilizer expense showing optimum rate.



**Figure 1b.** Phosphorus content of harvested alfalfa tissue at mid-bud stage as influenced by rate of  $P_2O_5$ /acre at each cutting.



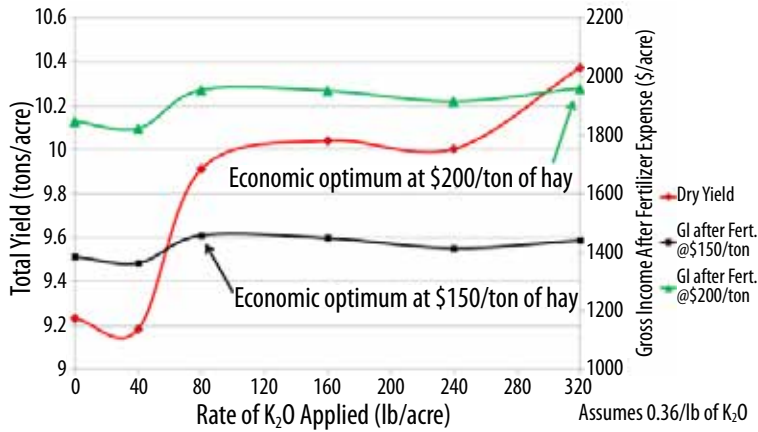
- Phosphorus impacts are greater the 2<sup>nd</sup> year as reflected by the reports recommended % tissue P. See **Table 1** for optimum tissue P at mid-bud for second year alfalfa based on hay price.

- Relative Feed Value for 1<sup>st</sup> cutting was raised from 169 to 211 RFV units by applying 240 RFV units. However, this influence was not found in other cuttings as soils warmed up.

## RESULTS – K STUDY

- The ideal time to test for K using our data is at the 2<sup>nd</sup> cutting at mid-bud stage where optimum is >2.4% K when hay price is \$150/ton, but much higher when hay is \$200/ton.

**Figure 2.** The economic optimum for K<sub>2</sub>O rate.



**Table 2.** K<sub>2</sub>O removal rates are high.

K <sub>2</sub> O Rate (lb/acre)	K Rate Applied (lb/acre)	Yield (tons/acre)	Whole Plant K (%)	# of K Removed (lb/acre)	K <sub>2</sub> O Removed (lb/acre)
0	0.0	9.2	2.1	382	458
40	33.3	9.2	2.0	360	432
80	66.7	9.9	1.9	376	451
160	133.3	10.0	2.2	438	526
240	200.0	10.0	2.4	473	567
320	266.7	10.4	2.5	514	616

## MANAGEMENT RECOMMENDATIONS/CONCLUSIONS

- Phosphorus and potassium needs are greater in the second production year, thus % P should be greater. Second year alfalfa, optimum P alfalfa tissue phosphorus content current yields should be based on hay price and cutting at mid-bud stage. For \$150/ton hay P contents of: 0.34, 0.40, 0.36, 0.34, 0.32 for cuttings one, two, three, four and five, respectively. For \$200/ton hay P contents of 0.35, 0.41, 0.37, 0.34, 0.32 % for cuttings one, two, three, four and five, respectively.
- The second harvest is the ideal time to test for potassium based on our data. For mid-bud harvests K content of hay 2<sup>nd</sup> cutting should be >2.4% K when hay price is \$150/ton. Alfalfa yield may continue to increase paying for additional K fertilizer if hay price is at \$200/ton or more.
- First- and second-year data show that struvite can be used alone or in combination with MAP without a yield loss even on a soil averaging 8.1 ppm (Olsen P Method).

## RESULTS – STRUVITE STUDY

**Figure 3.** Struvite did not decrease yield when applied at same 144 lb P<sub>2</sub>O<sub>5</sub>/acre rate as MAP (monoammonium phosphate).

