



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

Steve Norberg, Steve Fransen, John Harrison,
Don Llewellyn, Liz Whitefield, Washington State University

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 from 2018–2020.

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).

RESULTS – P STUDY

- The optimal P content was found to be 0.355 and 0.36 % P for \$150 and \$200 per ton hay, respectively (Table 1). Optimum P content was based on mid-bud stage hay harvested and averaged over three years (1998–2000) under irrigation near Prosser, WA. The optimal P content should be applicable of a wide range of locations, however economics will vary based on productivity of the field. This field was harvested five times and yielded approximately 10 tons acre in years 2 and 3. Sixty-seven percent of the yield increase was in the first and second cuttings.

Table 1. Hay phosphorus (P) content's impact on dollars lost by misapplying P and amount of P to adjust next years rate.

Hay P Content	Amount to increase or decrease (lb P_2O_5) rate next year		Dollars lost by misapplying P over 3 years	
	@\$150 ton hay (lb P_2O_5 /acre)	@\$200 ton hay (lb P_2O_5 /acre)	@\$150 ton ⁻¹ (\$)	@\$200 ton ⁻¹ (\$)
%				
0.24	150	160	330	522
0.26	130	140	250	406
0.28	110	120	175	294
0.30	80	100	108	193
0.32	60	70	52	104
0.34	30	40	12	35
0.36	-10	0	2	0
0.38	-80	-70	99	92

RESULTS – K STUDY

- Yield increases occurred with applications of potassium sulfate in 2019 and 2020 (Figure 1a). No yield response was found in the year of spring establishment 2018. Potassium contents of the forage is shown in Figure 1b. In 2020, the third year of the experiment, application of K_2O failed to match the K forage content in the hay in the previous two years as both K accumulated was less and increased yield diluted K content. Optimum K tissue concentration for \$200/ton hay without quality consideration was 1.9 and 1.6% in 2019 and 2020 respectively. In 2019, RFQ was increased from 182 to 255 by increasing rate to 320 lb/ K_2O per acre. During the three years the 320 lb/acre treatment soil available K decreased in the soil from 92.8 ppm in spring of 2018 to 62 ppm in the fall of 2020, a 33% reduction from beginning to end of the experiment. A total of 960 lb/a K_2O was applied in three years, however 1,166 lb/a K_2O was removed in the hay.

Figure 1a.

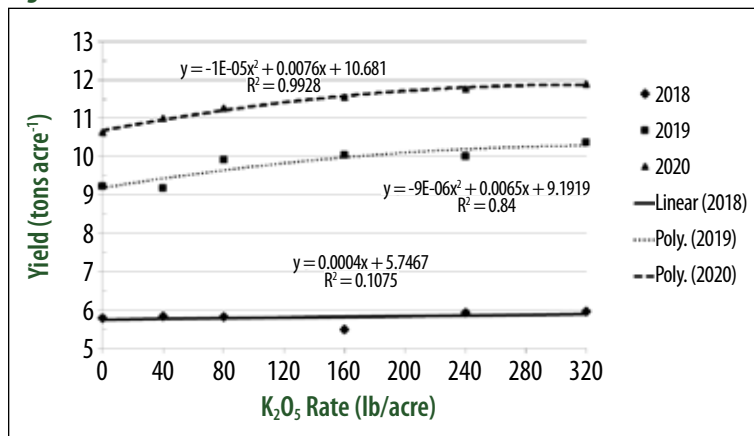
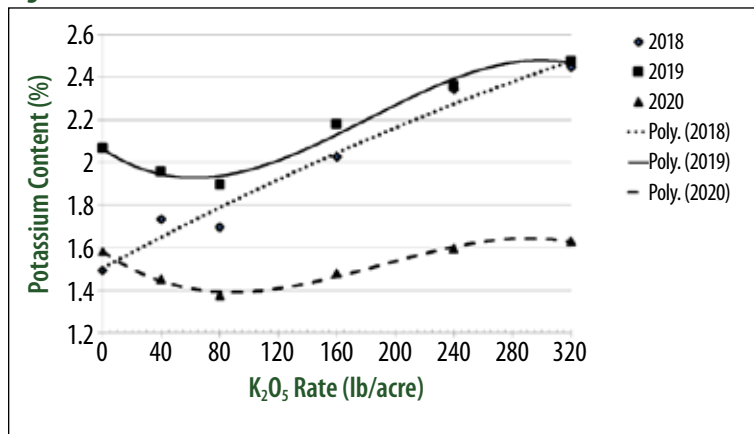


Figure 1b.



MANAGEMENT RECOMMENDATIONS/CONCLUSIONS

- To maximize economic return, phosphorus content of alfalfa hay should be near 0.36% when harvested at mid-bud stage for hay harvested at 2 inches. This is higher than published elsewhere.
- The optimum K content for the two years was 1.9 and 1.6% for 2019 and 2020, respectively.
- Three years of data show that granular 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

- Total 3-year yields were similar when struvite percent of struvite increased when applied at same 144 lb P₂O₅/acre rate as MAP (monoammonium phosphate) (Figure 2a). Phosphorus content also similar P content when struvite portion of P₂O₅ was increased (Figure 2b).

Figure 2a.

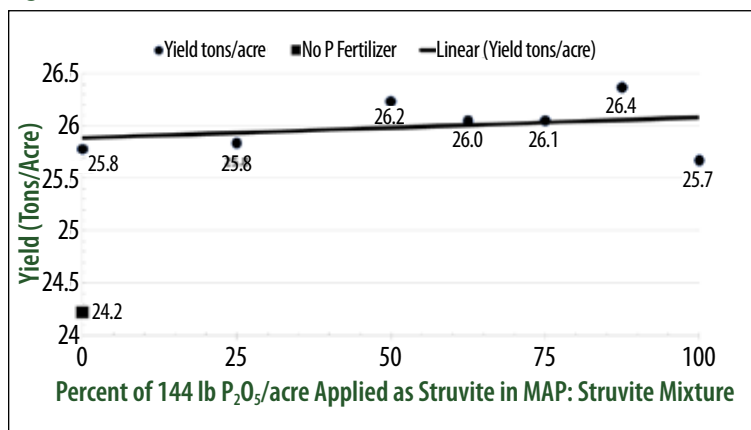


Figure 2b.

