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

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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 K 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:

Results were analyzed for yield, P or K content (ICP method), hay quality (NIRS method), maturity at harvest.

RESULTS – P STUDY

Figure 1a. First cut yield and P content (%) in hay at harvest as influenced by P_2O_5 rate.

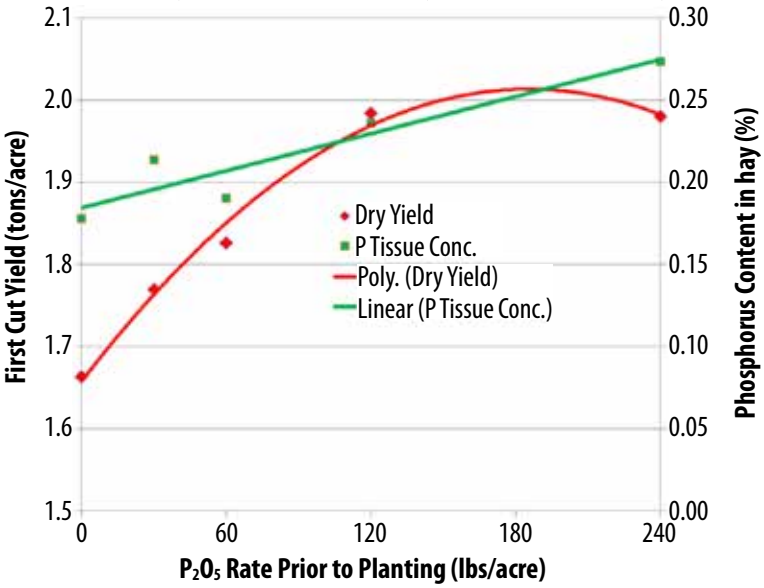


Figure 1b. First year yield and gross income minus fertilizer cost as influenced by P_2O_5 rate.

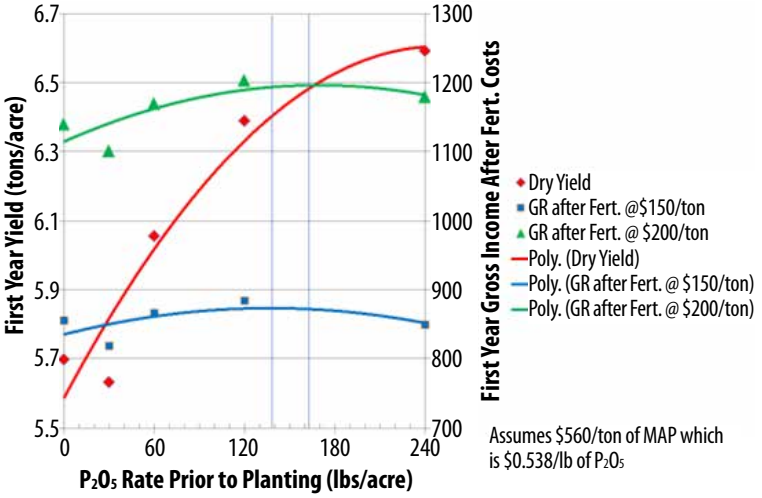


Figure 1c. Field view of control and high rate of P_2O_5 in summer 2018.

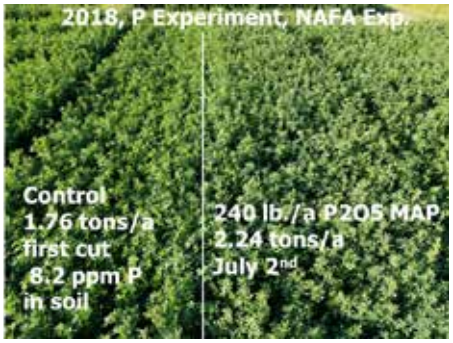
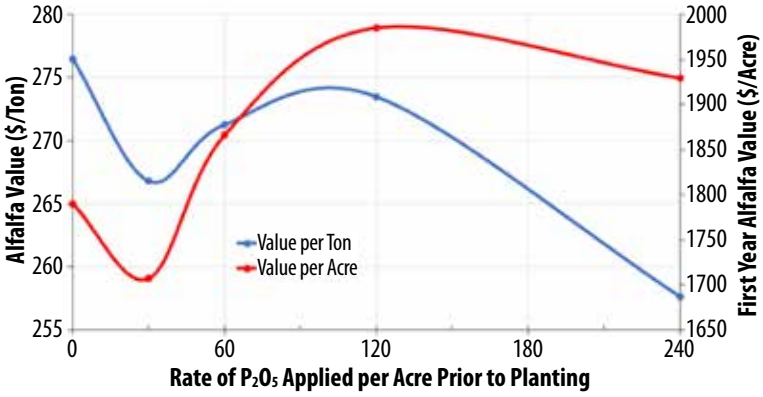


Figure 1d. Influence of P_2O_5 on value of alfalfa hay on per ton and first year of alfalfa value from a PNW nutrient value basis.



- 140 and 165 lb/acre P_2O_5 maximized first year gross revenue, after fertilizer costs, when soil was 8.1 ppm Olson P method and price of alfalfa hay valued at $150 and $200/ton respectively.
- Optimum alfalfa tissue P concentration was 0.24-0.25 for first cut, 0.28 - 0.29 for second cut, and 0.26-0.27 for third cut for alfalfa hay priced at $150 and $200/ton respectively.
- Applications of P_2O_5 decreased hay quality so accurate rates are important to maximize profit.

RESULTS – K STUDY

- The experiment started with a 101, 73, and 79 ppm K_2O in the soil (ammonium acetate method) at depths of 0-12, 12-24, and 24-36 inch depths respectively, which we did not see a yield response, yet 240 lb K_2O treatment pulled 308 lb K from the soil as opposed to no application which pulled 198 lb K from the soil. Current soil testing recommendation would have been 100 lbs/acre. K_2O treatment 240 lb/acre decreased RFV and RFQ and increased lignin. Further research is needed.

RESULTS – STRUVITE STUDY

- Source of P_2O_5 had no effect on first cut or first year yield or P_2O_5 content.
- Phosphorus was needed in this trial both in first cut and first season yield and P_2O_5 content.

Figure 2a. In 2018, first cutting dry matter yield and P_2O_5 content as influenced by P_2O_5 source and no fertilizer.

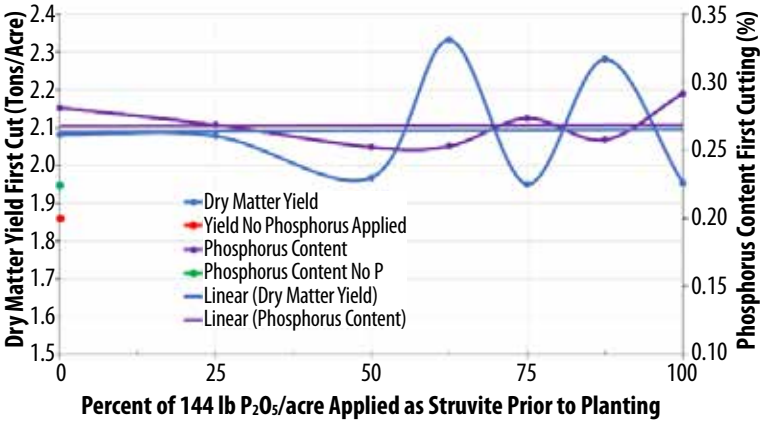
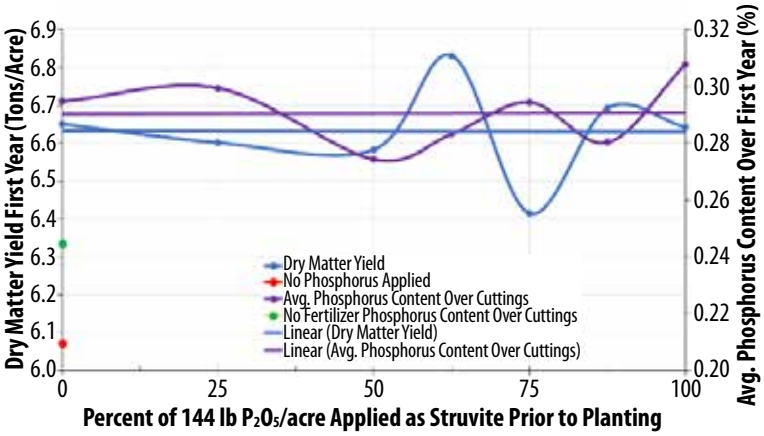


Figure 2b. First year dry matter yield and averaged P_2O_5 content in the three cuttings harvested in 2018 as influenced by P_2O_5 source and no fertilizer.



MANAGEMENT RECOMMENDATIONS/CONCLUSIONS

- Optimum P alfalfa tissue P_2O_5 content based on first year of the experiment should be between 0.24-0.28 and 0.25-0.29 when the alfalfa hay price of $150 and $200/ton, respectively.
- First year data show that struvite can be used alone or in combination with monoammonium phosphate (MAP) when put on prior to planting and incorporated without a yield loss even on a soil averaging 8.1 ppm (Olson Method).
- Excessive P_2O_5 of K_2O has a negative affect on hay quality and can affect aNDF, lignin, RFV, RFQ, and nutrient value of hay ($/ton).

Alfalfa
U.S. Alfalfa Farmer Research Initiative

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