

2017 USAFRI Research Project Objectives

Developing Practical Phosphorus and Potassium Tissue Test Recommendations and Utilizing Struvite in Modern Alfalfa Systems Washington State University - Norberg

Project Award: \$40,000

Justification:

- Most inorganic Phosphorus (P) fertilizers are derived from phosphate rock, where 98% of the reserves are in other countries with the USA only holding 2% (Stewart 2002, USGS 2013). Dairies accumulate P and need outlets for P and each dairy farm has a unique need for P removal to reach a whole farm P nutrient balance (WA Dept. of Ecology). In contrast, alfalfa (*Medicago sativa*) producers need to reverse the trend of declining soil test P content to maintain high crop yield and quality. To compound the problem just a few years ago the price of commercial P fertilizers soared to record high prices, and will likely to do so again as reserves diminish and struggle to accommodate increasing demand. A viable solution is the adoption of technology to capture P from liquid manure in the form of 'struvite', a slow release form of P based fertilizer. Current PNW struvite NPK fertilizer has an analysis of (6 – 29 – 0) including 16% magnesium, easy to handle and transport due to its low moisture content, and looks much like sand. More research is needed in the use of struvite in alfalfa and would supplement the efforts of a recent federal USDA -NRCS-CIG grant titled "Mobile System for Nutrient (Phosphorus) Recovery and Cost Efficient Nutrient Transport". This proposal is supported by Washington State Hay Growers Association (WSHGA), which are NAFA member with Brian Eddie the current WSGHA President. Brian Eddie is one of two producers we've identified having struvite applied to his alfalfa farm in the summer of 2017." which is making struvite from PNW dairies (see support letter). This complimentary federal grant project will demonstrate the farm-scale deployment of a mobile system for economical and efficient means of capture and subsequent transport of nutrients from a region or P density to an area of forage production that needs supplemental P. The use of a nutrient recovery system (struvite technology), has already been in use for large wastewater plants for cities and is now being processed in mobile units with dairies that are closer to alfalfa producers which may reduce costs to alfalfa producers. Our grant "Developing Practical Phosphorus and Potassium Tissue Test Recommendations and Utilizing Struvite in Modern Alfalfa Systems" proposal is also supported by Washington State Hay Growers Association (WSHGA) is a NAFA member with Brian Eddie President (see support letter). Brian Eddie is also one of two producers we've identified having struvite applied to his alfalfa farm in the summer of 2017 as a part of the federal grant.

With high P and K costs it is important to apply nutrients only when needed, often using one foot calibrated soil tests. Alfalfa plants can remove potassium and other nutrients from much deeper depths creating disproportional inaccuracy crop response and soil test results. Tissue testing provides the opportunity to direct nutrient decision making accurate, critical levels in season recommendations for possible applications between cuttings or through fertigation. California scientists have developed the alfalfa tissue testing protocols, however producers are not adopting because the test uses the middle third of alfalfa at one-tenth bloom for P & K (Meyer et al., 2008). One-tenth bloom is well past dairy quality hay stages for most PNW producers, making this California recommendation impractical. Alfalfa tissue testing has been proposed in New Mexico, which recommended a wide range from 2.0 to 3.5% K in the upper $\frac{1}{3}$ of the plant at early bloom (Flynn et al., 1999). The current Pacific Northwest alfalfa fertilizer guide has a critical level of 2.0 to 2.5% for the whole plant at first bloom but needs further refinement (Koenig et al., 1999). Research conducted in Israel suggests maximum alfalfa yield K levels should remain above 2.5% at harvest (Kafkafi et al., 1977). This research and other reveals P & K concentrations decline with crop maturity indicating the importance of the timing of tissue testing.

Phosphorus and potassium are the most important cations in regard to content in plant tissues but also in biochemical and physiological processes (Mengel and Kirkby, 1987). Fertilizer is the largest single expense in an irrigated alfalfa budget for the western U.S. Even at modest rates, fertilizer can easily reach over \$216 per acre with P & K being the largest component (Norberg and Neibergs, 2014). More K is removed from the soil by alfalfa than any other nutrient (Koenig and Barnhill, 2006). Alfalfa can remove 8 lb.P₂O₅ and 54 lb. K₂O per ton of alfalfa produced (Koenig, et al., 2009), which for yields of 10 tons per acre attainable by excellent producers in the PNW, result in 80 lb.P₂O₅ and 540 pounds K₂O removable per acre per year. We are proposing to use the harvest time of mid to late bud stage (typical harvest timing for first cutting) and use the whole plant which could be taken the same time and method as currently being used for quality analysis. We have selected first cutting, the one most desired by the dairy industry, as this is most likely cutting to be nutrient limiting due to cold soils, but we are proposing to test all alfalfa cuttings.

Struvite provides a slow release option we believe would work best in combinations with faster release forms such as mono-ammonium phosphate (MAP). This research impacts and has relevance to with USAFRI Research Priorities of Yield, Fertility and Quality of Alfalfa.

Objectives:

- The objectives of this project are to 1) develop and calibrate P & K nutrient recommendations for bud stage alfalfa using tissue testing for maximum profit, yield and direct comparison to current soil testing recommendations; 2) compare efficacy of combinations of MAP and struvite for fertilization of alfalfa; 3) evaluate quality of hay samples at different P and K rates and tissue concentrations, and 4) extend this information to a wide audience using a variety of outreach methods.