2018 USAFRI Research Project Objectives

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

Project Award: $50,000

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 complimentary federal grant project demonstrates 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. The technology is now being tested as a mobile unit with dairies in hopes to reduce costs in producing struvite.lfa producers. Part of this grant is applying struvite on two alfalfa producers' fields as demonstration sites. This proposal, "Developing Practical Phosphorus and Potassium Tissue Test Recommendations and Utilizing Struvite in Modern Alfalfa Systems" is supported by Washington State Hay Growers Association (WSHGA), a NAFA member showing that dairies need to move P off their farms and whereas alfalfa farmers need other sources of P fertilizer and that soil testing may not be the best method of determining P application. This proposal is unique and innovative and addresses a new P source and rate of P and K fertilizer questions with an excellent team approach.

  With high P and K costs it is important to apply nutrients only when needed, often using onefoot calibrated soil tests. Alfalfa plants can remove potassium and other nutrients from much deeper depths creating disproportional inaccuracy in crop response related to 1 ft soil test results. Tissue testing provides the opportunity to make nutrient application more accurate and determine in-season critical levels that would determine recommendations for applications between cuttings or through fertigation. California scientists developed the alfalfa tissue testing protocols, however producers are not adopting the test because it uses the middle third of the alfalfa plant at the one-tenth bloom for assessing P and K (Meyer et al., 2008). One-tenth bloom is well past the stage of dairy quality hay 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 1/3 of the plant at early bloom (Flynn et al., 1999). The current PNW 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 and K concentrations decline

with crop maturity indicating the importance of the timing of tissue testing.

Phosphorus and potassium nutrients are the cations in greatest concentration in alfalfa plant tissues, are often recommended and are integral to biochemical and physiological processes (Mengel and Kirkby, 1987). Fertilizer is the largest single expense in an irrigated alfalfa budgetfor the western U.S. Even at modest rates, fertilizer can easily reach over $216 per acre with P and 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 lbs. of P2O5 and 54 lbs. K2O per ton of alfalfa produced (Koenig, et al., 2009). With yields of 10 tons per acre attainable by excellent producers in the PNW, this results in 80 lbs. P2O5 and 540 lbs. K2O removed per acre per year. We are proposing to harvest at mid- to late-bud stage (typical harvest timing for first cutting) and use a whole plant sample. This method would allow producers to use their sample currently pulled for hay quality to also be used for P and K nutrient testing once it is calibrated. We have selected first cutting to be of primary interest. It is the one most desired by the dairy industry, and most likely the cutting to be nutrient limiting due to cold soils. However, to follow all nutrient movements in and out of the system 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. Likewise, this project fits USAFRI Research Priorities: Emerging Technologies, Fertility and Agronomic Management and has the ability to transfer research findings to alfalfa producers operations over a wide geographic area.

Objectives:

- The objectives of this project are to 1) Develop and calibrate P & K nutrient recommendations for tissue testing at bud stage alfalfa 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.