# Fertilizing High Producing Alfalfa Stands

Edwin Ritchey
Extension Soil Specialist
University of Kentucky Research and Education Center at Princeton

There are no secrets for successfully producing a high quality alfalfa crop. Successful alfalfa production is a product of suitable site selection, proper fertility and pH management, good pest control, and favorable weather conditions throughout the season. This paper focuses on proper fertility and pH management practices.

The basis for sustainable alfalfa production should consider agronomic, environmental, and economic factors. All three factors are addressed with appropriate soil sampling and testing protocols – the basis of any soil fertility program. Soil sampling involves collecting the representative samples within time and space to provide an estimate of the current nutrient status of a field. The recommendations provided by the soil test lab should be appropriate for the geographic production area. Land grant fertility recommendations are research-based for a specific geographical area. For example, University of Kentucky recommendations are well suited for Kentucky, but are not applicable for Texas agriculture.

Soil sample results and recommendations are only as accurate as the soil sample submitted to the lab. A good soil sample should represent uniform areas within an area no larger than 20 acres in size that avoids atypical areas such as eroded areas, feeding/watering/stalling areas, or other areas that differ substantially from the majority of the field. Collect a minimum of 10 cores (more is better) that represent the sample area, thoroughly mix in a plastic bucket and provide a subsample to the soil test lab in the recommended sample box or bag. Avoid using galvanized and rubber buckets due to potential zinc contamination from the buckets.

Annual soil sampling is recommended for high value crops and crops with high nutrient removal rates, both common to alfalfa. Sample depth is dictated by tillage practice. When tillage is used to establish alfalfa, sample to six inches or the depth of tillage. Collect soil samples to a depth of 4 inches for established alfalfa and when established using no-tillage (NT) practices. The timing of sampling is not critical, but be consistent. Fall and spring sampling can provide slightly different results. The key is consistent sample timing and comparing soil test trends over time to determine if slight adjustments in fertility additions is needed.

The University of Kentucky Cooperative Extension Service recommends the following target values for alfalfa production:

Soil pH = 6.8

If soil pH < 6.2 at seeding, apply 1 lb sodium molybdate/A, but no more than 2 lb sodium molybdate/A in a five-year period.

Soil Phosphorus (P) = 60 lb/A

Soil Potassium (K) = 450 lb/A

Hot Water Extractable Boron (B) = 2 lb/A

The values listed above are “target values”, but yield loss is not guaranteed at lower levels. Soil pH management is the foundation of any soil fertility program and influences nutrient availability, root growth, and activity of certain herbicides. The target pH 6.8 helps to ensure that Mo availability is maximized while not limiting the availability of other essential nutrients (Figure 1). Molybdenum is essential for biological N fixation. The addition of agricultural limestone, calcitic or dolomitic, is the most economical method to increase soil pH for alfalfa production. Be aware that gypsum ($CaSO_4$) does not adjust soil pH since it does not consume acidity ($H^+$) present in the soil. Calcium and magnesium do not limit alfalfa growth in Kentucky when soil pH is maintained at or above pH 6.5.

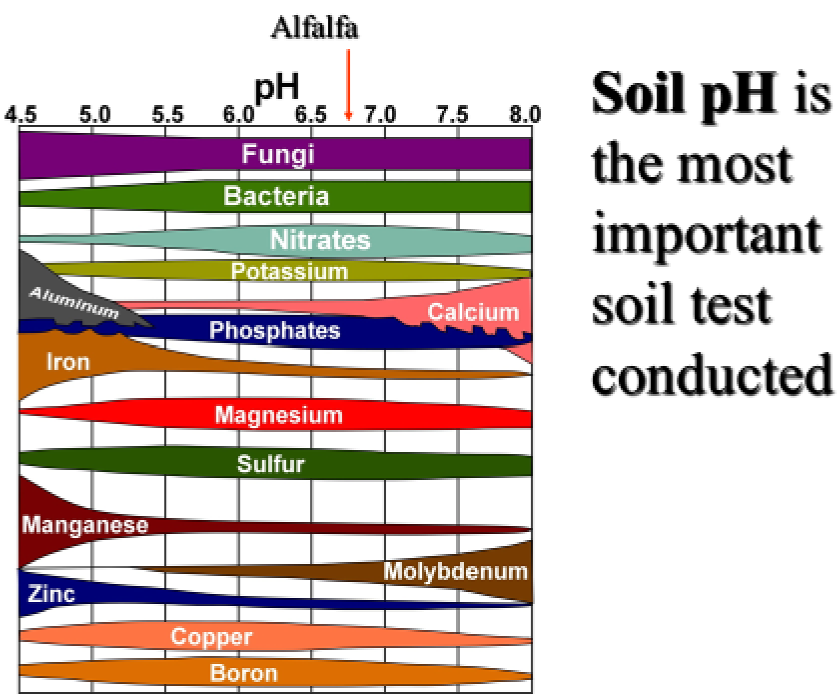


Figure 1. Nutrient availabilities as influenced by soil pH.

Phosphorus, known as the energy element, aids in energy storage created by photosynthesis, promotes root growth and seed development, and is a component of DNA and RNA. Phosphorus availability is maximized around a pH of 6.4 to 6.8. Phosphorus availability decreases outside of this range due to complexation with iron and aluminum at lower soil pH and by calcium at higher pH. Diammonium phosphate (DAP) with a nutrient analysis of 18-46-0 or monoammonium phosphate (MAP) with a nutrient analysis of 10-52-0 are the two most common and economical P fertilizers used for alfalfa production in Kentucky.

Potassium is an important component of photosynthesis, internal transport of nutrients within the plant, internal water regulation, and disease tolerance. Potassium differs from other plant nutrients as it is not consumed or incorporated into plant chemical compounds. Alfalfa has one of the highest K requirement of any plants. Certain plants, such as alfalfa, have the ability to take up K in excess of what is required for optimal function. This is known as luxury consumption and can result in excessive fertilizer expenditures that do not result in increased production. A split application of K fertilizer after the 1$^{st}$ and 3$^{rd}$ cuttings reduces the potential for luxury consumption when soil test K values are >300 lb K/A. Muriate of potash (KCl) with a nutrient analysis of 0-0-60 is the most common and economical K fertilizer used for alfalfa production in Kentucky.

Boron, a micronutrient, is needed only in small amounts but is involved with cell wall formation, cell division, translocation of sugars and starches, and nodule formation. Mehlich 3 extractable B is not as good in determining potential B need for alfalfa as a hot water extractable B. If hot water extractable B < 2 lb/A then an application of 1.5 to 2 lb B/A can be applied every other year. Do not apply B if hot water extractable B > 2 lb/A. Most of the B fertilizer derived from sodium borates are very soluble in water and equally effective per unit of B.

Sulfur (S) is a component of proteins, important for chlorophyll synthesis, and involved with vitamin production. Alfalfa removes approximately 5 lb S/ton of hay. Historically, adequate S was provided by atmospheric deposition and fertilizer impurities that remained from the manufacturing process. Atmospheric deposition has reduced substantially in the past 15 to 20 years due to air quality regulations (Figure 2) and improved fertilizer production technologies have reduced the amount of residual S contained in fertilizers. Although external inputs of S have decreased over the years, many soils contain a substantial amount of readily available S in the subsoil due to previous atmospheric deposition over time.

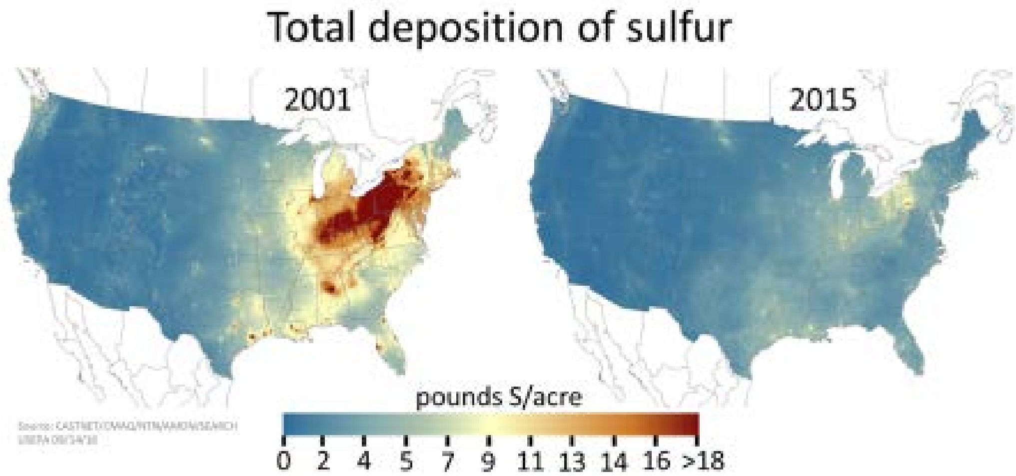


Figure 2. Changes in atmospheric deposition rates for sulfur between 2001 and 2015.

Currently, there is no valid soil test for S in Kentucky. The Mehlich 3 soil test extractant used for P, K, magnesium, zinc, etc. is not correlated or calibrated for sulfur recommendations for any crop in Kentucky. The best method to determine S need is based on good tissue sampling protocol and visual examination of the crop. Sulfur deficiency is characterized by light green to yellow leaves on the upper canopy and spreads downward if the problem continues. If S fertility is limiting alfalfa production, the most economical source of S is gypsum ($CaSO_4 * 2H_2O$) containing 19 lb S in each 100 lb gypsum.

Several tissue surveys were conducted across Kentucky in wheat and alfalfa from 2011 to 2014 (Figure 3). One wheat sample out of approximately 70 samples resulted in tissue S below the reported sufficiency range. A similar survey was conducted for alfalfa in 2013 and 2014 with different results. Six out of 24 samples collected were below the sufficiency range in 2013. Response trials were conducted on 5 of the 6 fields in 2014 to determine if sulfur was limiting alfalfa yields. Gypsum was applied at 25 or 50 lb S/A after the first cutting and yields were collected for the $2^{nd}$ and $3^{rd}$ cutting. No significant yield increases were observed for the pooled data at either rate when compared to the non-treated check plot (Figure 4).

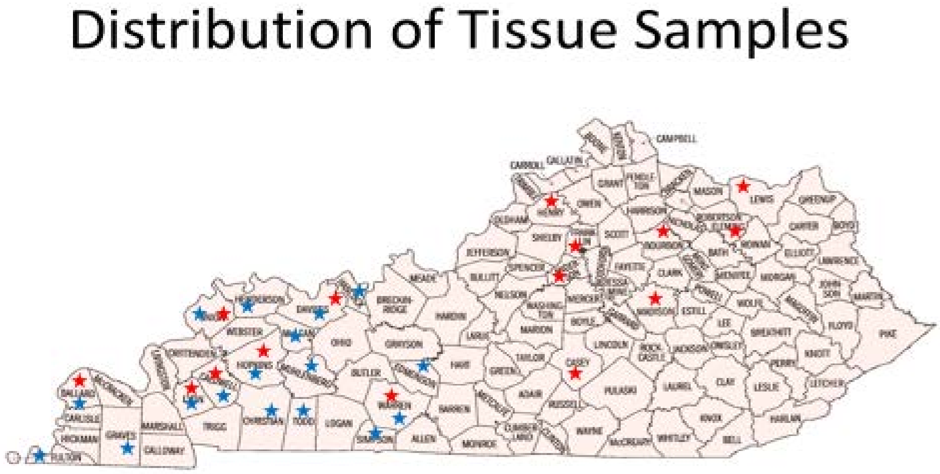


Figure 3. Location of tissue samples collected across Kentucky. Red stars indicate alfalfa samples and blue stars indicate wheat samples.

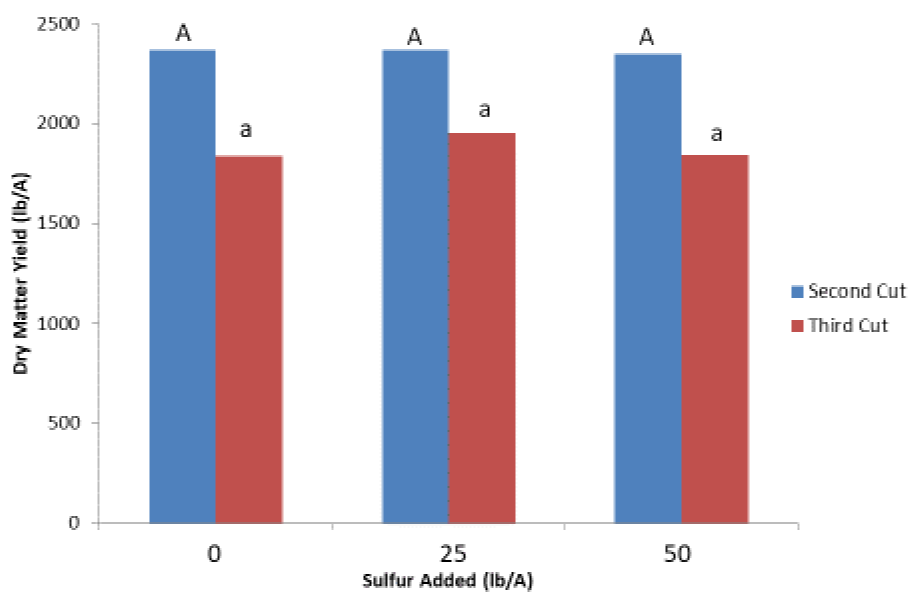


Figure 4. Alfalfa yields pooled across 5 locations for the second and third cutting after sulfur additions.

In summary, successful production of alfalfa results from following the basics and favorable growing conditions. Annual soil sampling to determine nutrient needs should be the basis of a soil fertility program for alfalfa due to its high value. Proper soil pH management is the foundation of a good soil fertility program and is one of the cheapest inputs involved with alfalfa production. Maintaining soil test P and K in the medium range or higher will ensure that soil fertility status is not limiting production potential. However, luxury consumption of K will occur at high soil test levels and will increase fertility costs without improving alfalfa yields. Making K fertility application after the 1st and 3rd cuttings limits potential luxury consumption of K. Properly managed alfalfa stands can provide profitable yields for several years and managing fertilizer inputs is key to stand longevity.

## Additional Resources


Ritchey, E.L., D. Ditsch, L. Murdock, G.J. Schwab. 2014. Fertilizer Management in Alfalfa. University of Kentucky Cooperative Extension Publication AGR-210.

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Schwab, G.J., C.D. Lee, R.C. Pearce. 2007. Sampling Plant Tissue for Nutrient Analysis. University of Kentucky Cooperative Extension Publication AGR-92.

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