Dr. Richard Koenig

Keep Close Watch on NPKs Fertilization of Alfalfa

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Summary: *Few studies have found positive effects of nitrogen (N) fertilization on established alfalfa. Situations where alfalfa may respond to N include poor or ineffective nodulation due to use of a wrong, old or damaged inoculant, and stresses that can reduce nodulation or bacterial activity. Phosphorus (P) is the most common fertilizer input for alfalfa across the Western U.S. It is essential for optimum alfalfa production. A long history of high-yielding alfalfa production has frequently depleted native soil potassium (K) levels to the extent that most Western states now encourage testing for K. Yield responses to sulfur (S) in alfalfa of up to 300 percent have been reported where there is severe soil S deficiency.*

Alfalfa is the most common legume forage crop grown in the Western States. As recently as 1997, over 32 million tons of alfalfa was produced on approximately 7.4 million Western acres. In addition to its economic importance, alfalfa also fills an important rotational niche in Western agriculture. Being a deep-rooted crop, alfalfa can scavenge nutrients remaining after the growth of less efficient, shallow rooted crops.

Determining when applications of NPKs are needed is important to ensure adequate alfalfa yield and quality. Over-generalizations made about the occurrence of NPKs deficiencies are dangerous. Western U.S. climates, soil types, historical nutrient use patterns and alfalfa production systems are highly variable and directly impact the need for NPKs. Therefore, some form of soil and tissue testing must be used to identify deficiencies and monitor the nutrient status of alfalfa.

We'll briefly review some of the criteria to use in determining what nutrient to use and at what rate.

Nitrogen

Nitrogen application in established alfalfa stands is still controversial. Application of larger amounts of N during establishment is thought to inhibit bacterial colonization of the root system and may reduce growth of mature alfalfa plants. Few studies have found any positive effects of N fertilization on established alfalfa; however, enough studies have shown a yield and/or protein response to N fertilization to warrant consideration.

Situations in which alfalfa may respond to N fertilization appear to include poor or ineffective nodulation due to use of the wrong, old, or damaged inoculant, and stresses that can reduce nodulation or bacterial activity. If producers suspect low rates of N fixation in alfalfa stands they should first try to identify the cause and then consider on-farm testing to determine whether or not fields will respond to N fertilization.

Phosphorus

Phosphorus is essential for alfalfa production and likely represents the most common fertilizer input for this crop across the Western U.S. Phosphorus recommendations in western states with alkaline-calcareous soils are based on a sodium bicarbonate ($NaHCO_3$) extractant or "Olsen" test. Correlations between soil test P and alfalfa yield are normally very good for the Olsen P test. These relationships are used to identify the critical soil test P above which fertilizer recommendations are not made.

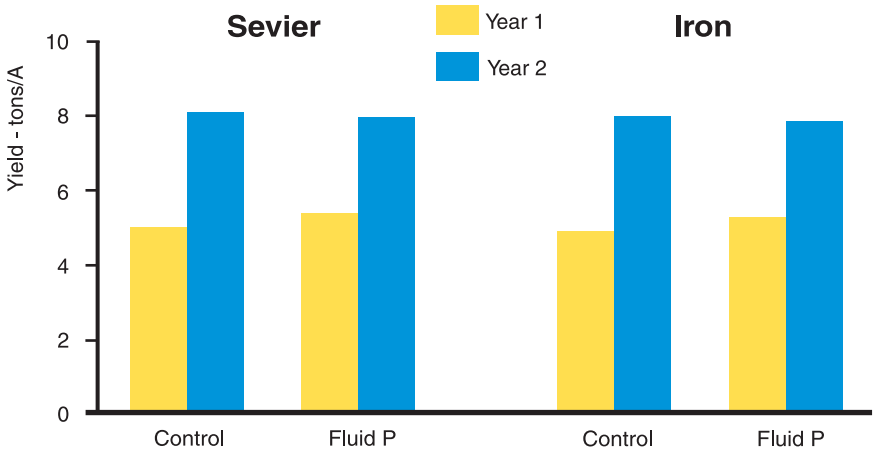

Figure 1. Effect of Fluid P on alfalfa yield at two locations. P applied at rate of 150 or 250lbs/A of P_2O_5.

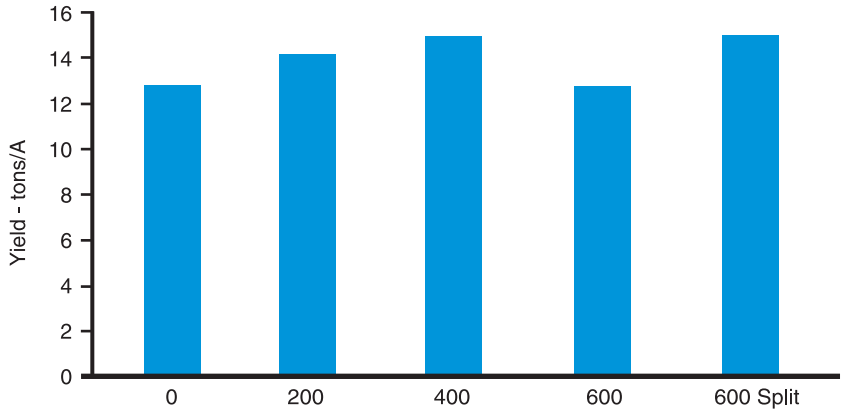

Figure 2. Effect of K rate on alfalfa field. Split applications consisted of 200 lbs/A of K_2O in April, plus 200 lbs/A after first and second cuttings (600 lbs/A of K_2O total).

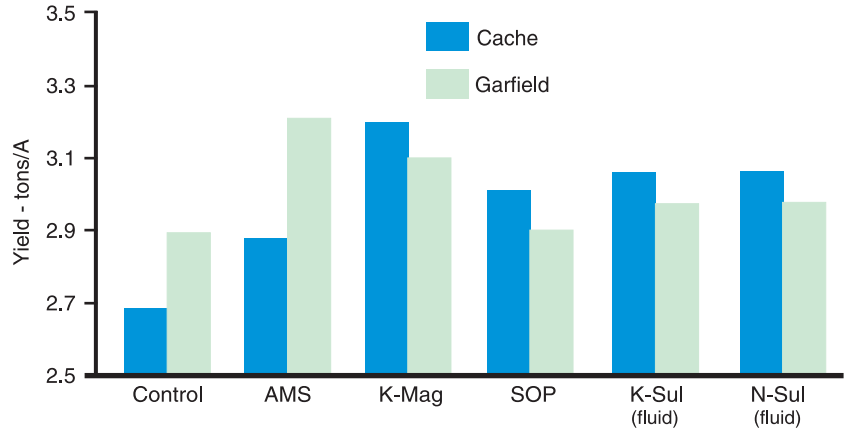

Figure 3. Effect of S on alfalfa yield at two locations, Cache and Garfield.

Fertilizer guides from most western states recommend that P be applied and incorporated before establishing an alfalfa crop. Since P is relatively immobile, placement below the soil surface improves root access and prevents P from being stranded on the surface of dry soil. When P needs are identified for established alfalfa, application as soon as possible is recommended. The effect of P fertilizer on alfalfa yield versus control at two Utah locations is shown in Figure 1.

Potassium

Potassium deficiency is a relatively recent occurrence in the West. A long history of high-yielding alfalfa production has depleted native soil K levels to the extent that most western soil testing labs now encourage testing for K, and make K fertilizer recommendations.

Soil test extractants for K include sodium bicarbonate ("Olsen" extract), ammonium bicarbonate, and ammonium acetate. Soil test procedures for K, like P, are reliable indicators of deficiencies and fertilizer requirements. Recent research at Utah State University shows alfalfa yield responses to relatively high K application rates on low K–testing soils (Figure 2). Due to the high K requirements of alfalfa, frequent and relatively high rates of K fertilizer will be required to maintain high yields once native soil levels are depleted.

Sulfur

Sulfur is an important component of several amino acids and has been shown to influence the yield, protein content, stand density, and stand life of alfalfa. Yield responses of up to 300 percent have been reported under severe S deficiency conditions; however, more typical yield responses to S fertilization are in the range of 15 to 25 percent and highly profitable.

Soils at many high elevation locations have been found to be low in S. High precipitation, coupled with low irrigation water S concentrations and a history of high-yielding alfalfa production, explains the occurrence of these deficiencies. A recent comparison of S applications at two locations in Utah showed responses on the order of 16 to 20 percent above an unfertilized control (Figure 3). Initial soil test SO4-S ranged from 3 to 3.5 ppm.

Managing

The role and importance of on-farm testing and record keeping cannot be overstated when developing an alfalfa fertility program. Different soils respond differently to fertilization in terms of the initial and long-term impacts on soil test levels and crop response. Also, different yield levels will require different amounts of fertilizer inputs over time.

An on-farm test might involve determining whether or not alfalfa responds to N, or whether or not a higher rate of P or K will produce higher yields. Multiple strips are useful when comparing new practices in one strip and standard practices in another. Keep individual records of fertilizer applications, soil and tissue test values, and alfalfa yield to assess whether or not the new practice improved yield and quality, changed soil test values, and improved profitability.

Dr. Koenig is extension soils specialist in the Department of Crops and Soils, Washington State University, Pullman, WA. ❑