Soil Fertility Management for Newly Established Alfalfa

Marisol Berti, David Franzen, North Dakota State University

Alfalfa is a key component of dairy and/or beef farm operations. Its productivity and profitability depend, for the most part, on a well-managed fertilizer program. Alfalfa hay removes great amounts of minerals from the soil which need to be replaced by fertilization. If nutrient levels are deficient, alfalfa establishment might be reduced and productivity thereafter will decrease.

Before alfalfa establishment, preferably in the fall, it is very important to soil test to determine soil pH, phosphorus, and potassium. These are usually the three most important fertility issues to consider before planting since they are difficult to fix once alfalfa is established.

Soil pH required for maximum alfalfa production is ~6.7. When soil pH is >6.7, there is no reduction in yield potential. Estimates of potential yield reduction due to low pH are: 7% reduction for pH 6; 28% for pH 5.5; and 42% for pH 5. Soil pH also influences stand longevity and stand density prior to establishing a subsequent crop. Low pH results in a lower producing stand and consequently less nitrogen (N) credit for a subsequent crop after alfalfa termination. Since one of the consequences of low surface soil pH is lower N fixation rates of *Rhizobia* bacteria, surface pH, as well as subsurface pH, should be near or above a pH of 6.7. The most easily accessible amendment in the northern Great Plains for increasing soil pH is sugarbeet waste lime. Generally, a loam soil with 3% organic matter would require ~2 tons/ac of 100% calcium carbonate equivalent liming material to increase the pH ~0.5 units. It can take several months to correct an acidic soil with pH ≤5.5. Alfalfa establishment might need to be delayed to correct the problem.

Phosphorus (P) nutrition is essential for highest yield within an environment. Adequate P speeds up establishment, especially in cool soils, and maximizes hay and forage yield in both high- and low-yielding environments. Ideally, soil test P levels should be >15 ppm prior to alfalfa seeding, so soil testing for P is extremely important. Farmers are encouraged to apply at least 200 lbs/ac of 11-52-0 prior to seeding. If the land is conventionally tilled, apply fertilizer prior to final tillage before seeding. If the field is in a no-till system, application with an air-seeder or knifed into the soil before seeding will provide subsurface P for initial growth. Phosphorus rates have shown subsequent P application is essential to maintain yield and stand life. The most consistently effective timing of annual maintenance P application is after first cutting. An explanation for this is that in early spring P is released from organic sources and is utilized to produce the first cutting, reducing need for early spring P application. However, during second cutting growth, release of soil P is low and supplemental P fertilization is required. Surface application results in efficient P uptake by rapidly growing alfalfa. A rate of 40-50 lbs/ac P_2O_5 as 11-52-0 or another water-soluble P fertilizer is sufficient to maintain yield and stand as an annual application regardless of yields achieved. Maintenance application in the fall after last cut is recommended. Soil freezing and thawing will move some P down to the soil to be available for spring growth.

Potassium (K) needs in alfalfa are high. Application of K should be related to soil test level, clay chemistry, and alfalfa tonnage removed the previous season. Initial K level should dictate pre-seeding K application. The soil cation exchange capacity (CEC) will also be useful to determine the initial K application rate the soil would support. Unfortunately, the CEC test utilized by most soil testing labs in the region will over-estimate CEC due to the influence of free Ca/Mg carbonates solubilized during the testing procedure and the presence of soluble salts in the testing solution from most of our soils.

With soil having CEC <10, it will not be possible to increase soil test K level (dry-based soil test K, 1-M ammonium acetate extraction) to >100 ppm. From a recent series of corn K-rate trials in North Dakota, it was found that the critical level of soil test K required was related to the ratio of smectite-chemistry clay to illite-chemistry clay. The critical K soil test level for alfalfa in the high smectite/illite ratio areas would be 200 ppm. For the low smectite/illite ratio areas, a critical level of 150 ppm should be used. If the soil test K levels are above the critical K level, K fertilizer need not be applied. A map of smectite/illite clay ratio of North Dakota needed to determine the appropriate K fertilization strategy is included in the new alfalfa fertility bulletin SF1863 (see footnote).

If the soil test K level is at or below the critical level, then supplemental K application will be important to maintain stand life and high yield for a given environment. Early spring K release from soil minerals will sustain alfalfa through first harvest, but after first harvest, K application based on removal by the previous year's yields will be essential to maintaining stand life productivity. Even if K application is not needed, K plays an important role in winter survival of alfalfa. Potassium facilitates the translocation of sugars and other compounds from the plant's top to the crown and roots during the acclimation process of alfalfa late in the fall, increasing winterhardiness. Thus, in general, it is recommended to apply at least 60 lbs of K_2O/ac after the last cut of the season regardless of soil test.

Sulfur (S) deficiency in alfalfa is not common in North Dakota; however, S deficiency has been observed on loamy sand to sandy loam low-organic-matter soils in the region. Sulfur deficiency has become an annual problem for farmers of many annual crops within the past 10 years due to increased yields, increased rainfall, and reduced S contributions from rainfall. Sulfur deficiency will appear in fields first on coarser-textured, higher-landscape positions, particularly following periods of high spring rainfall. Deficiency symptoms will appear as yellowing near the growing point of plants, with green leaves below. An application of granular gypsum (calcium sulfate), ammonium sulfate, K-Mag, or related materials will alleviate the problem. Phosphate sources with sulfate-S embedded within the granules will also aid in alleviating and preventing deficiencies of S.

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