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FERTILIZER MANAGEMENT FOR ALFALFA

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INTRODUCTION

Alfalfa is well-adapted to many of Utah's climate and soil conditions. With proper variety selection and favorable irrigation, fertility, pest, and harvest management, Utah farmers have reported yields of 8 and even 10 tons/acre. Management is the key to successful alfalfa production. Supplying the correct amount of nutrients is one important management factor in profitable alfalfa production.

FERTILITY REQUIREMENTS

Alfalfa removes large quantities of nutrients from soil (Table 1). Historically, phosphorus has been the nutrient needed in largest quantities for alfalfa production in Utah. Potassium, sulfur, zinc, and boron deficiencies have also been documented in some locations. Nutrient deficiencies can significantly reduce alfalfa yields and shorten stand life.

Soil Testing is Essential!

It is difficult to generalize about the location and occurrence of specific nutrient deficiencies in Utah. Soils are inherently variable due to both geologic processes and historic manure and inorganic fertilizer use. In addition, some irrigation water sources add nutrients to soil. *For these reasons, soil testing is essential to determine which nutrients are needed and in what amounts for alfalfa production.* Fertilizer recommendations described in this guide are based on the latest research from Utah State University trials, and are updated frequently as new information becomes available.

FERTILIZER RECOMMENDATIONS

Nitrogen. Alfalfa is a legume and through a symbiotic relationship with bacteria obtains all of the nitrogen required for growth from the atmosphere. During establishment and before the bacterial symbiosis develops, a small amount of nitrogen (20 to 40 lb N/acre) is beneficial. Applications of larger amounts of nitrogen during establishment inhibit bacterial symbiosis and may actually reduce the growth of mature alfalfa plants.

Nitrogen application on established alfalfa is not recommended. Over 100 studies have evaluated alfalfa yield and protein responses to nitrogen fertilization, and very few have shown any positive effects. In studies where yield responses to nitrogen were obtained the response was relatively small and inconsistent (e.g., observed in one year out of three), nitrogen rates were often high and not economical, and responses were frequently due to a stimulation of grass in the stand.

Table 1. Average nutrient concentrations and removal by alfalfa.

Nutrient	Dry matter concentration	Removal per ton of hay
Potash	3.0 % K_2O	60 lb K_2O
Phosphate	0.75 % P_2O_5	15 lb P_2O_5
Sulfur	0.25 % S	5 lb S
Zinc	0.002 % Zn	0.04 lb Zn
Boron	0.003 % B	0.05 lb B

Phosphorus. Phosphorus deficiency (Figure 1) is common throughout Utah. Phosphorus recommendations based on current soil test results are summarized in Table 2. These recommendations are for a 7 ton/acre yield goal. For yields other than 7 tons/acre adjust recommendations by +/- 10 lb P_2O_5/ton of alfalfa.

Phosphorus movement in soil is very limited; therefore, where possible place phosphorus into the root zone by applying and incorporating fertilizer prior to establishing a new stand of alfalfa. Broadcast applications are also effective and should be made in the fall or early spring. In furrow irrigated systems, fall applied phosphorus is preferred since winter moisture helps to dissolve the fertilizer pellets.

Various sources of phosphorus are available in Utah, including triple superphosphate (0-45-0; 45% P_2O_5 by weight), monoammonium phosphate (11-52-0; 52% P_2O_5 by weight), and liquid phosphoric acid (various P_2O_5 concentrations). Comparisons indicate that, when applied at the same rate of P_2O_5, the materials mentioned above are equally effective. Select a phosphorus source based on local availability, ease of application, and cost per unit of P_2O_5.

Figure 1. Phosphorus deficiency in alfalfa: thin, weak stands with stunted plants and dark color.

Table 2. Phosphorus recommendations for two years of alfalfa production. Soil test phosphorus is based on a 12 inch sample depth and sodium bicarbonate soil extract.

Soil test phosphorus (ppm)	Recommendations (lb P_2O_5/acre)
0 to 3*	200-250
4 to 7*	150-200
8 to 10	100-150
11 to 15	50-100
> 15	0

*low soil test levels are severely limiting yield. Test soil annually until levels are adequate.

Potassium. Potassium deficiency (Figure 2) is associated with sandy soils, fields irrigated with clean waters low in potassium, and sites with a long history of high-yielding alfalfa production.

Potassium recommendations based on current soil test results are summarized in Table 3.

Alfalfa removes large amounts of potassium from soil (Table 1). Once a need for potassium has been identified, annual applications will generally be necessary to maintain soil test potassium and high yields. Multi-year applications of potassium are not recommended since alfalfa will absorb more potassium than needed for maximum growth. This trait is referred to as *luxury consump-tion* and results in the harvest of hay containing high concentrations of potassium.

Commonly available potassium sources in Utah are potassium chloride (0-0-60; 60% K_2O), potassium sulfate (0-0-50; 50% K_2O), and liquid potassium (various K_2O concentration). Select a potassium source based on local availability, ease of application, and cost per unit of K_2O.

Sulfur. Sulfur deficiency (Figure 3), although not a frequent occurrence, has been documented in some locations throughout Utah. Generally, sandy, low organic matter soils in areas with clean irrigation waters are subject to sulfur deficiency. Severe sulfur deficiency significantly reduces yield and lowers alfalfa quality. Sulfate-sulfur soil test values less than 8 parts per million (ppm) indicate the need for sulfur fertilization.

Common sulfur sources in Utah include ammonium sulfate (21-0-0-24S; 24% sulfur), potassium sulfate (0-0-50-18S; 18% sulfur), gypsum (17% sulfur), and elemental sulfur (0-0-0-90S; 90% sulfur). Where sulfur deficiency has been identified, application of 50 lb sulfate-sulfur (SO_4-S)/acre as ammonium sulfate, potassium sulfate, or gypsum combined with 100 lbs/acre of elemental sulfur (a slow release form of sulfur) will correct deficiencies for two to three years.

Micronutrients. Deficiencies of zinc, iron, copper, manganese, and boron are rare in alfalfa. Soil testing can be used to determine if these micronutrients are needed (Table 4). If

Figure 2. Potassium deficiency in alfalfa: browning and spots on leaf margins and tips.

Table 3. Potassium recommendations for one year of alfalfa production. Soil test potassium is based on a 12 inch sample depth and sodium bicarbonate soil extract.

Soil test potassium (ppm)	Recommendation (lb K_2O/acre)
0 to 40*	200
40 to 70	160
70 to 100	120
100 to 150	80
> 150	0

*low soil test levels are severely limiting yield. Test soil annually until levels are adequate.

Figure 3. Sulfur deficiency in alfalfa (right): short plants, thin stems, and light green color.

soil testing indicates a deficiency, apply 5 (for marginal levels) to 10 (for low levels) lbs/acre of zinc, manganese, or iron, or 2 to 3 lbs/acre of copper or boron. Sulfate salts are common sources of zinc, manganese, iron, and copper in Utah. Borax, sodium borate, and boric acid are common sources of boron.

Other nutrients. Deficiencies of other nutrients, primarily calcium and magnesium, have not been documented in Utah alfalfa. Western soils are generally well-supplied with these nutrients and supplemental fertilization should not be necessary.

Table 4. Micronutrient soil test values in parts per million (ppm) and interpretations for alfalfa.*

	Low	Marginal	Adequate
Zinc	<0.8	0.8-1.0	>1.0
Iron	<3.0	3.0-5.0	>5.0
Copper	<0.2	–	>0.2
Manganese	<1.0	–	>1.0
Boron	<0.25	0.25-0.5	>0.5

*DTPA extractable zinc, iron, copper, and manganese;

ADVANCED TECHNIQUES

Tissue testing. Tissue testing is a direct way to monitor nutrient levels in plants. A minimum of 10 whole plants should be collected from a field at early bloom and combined to represent the tissue sample. Keep tissue samples cool and transport them to a testing lab as soon as possible. Compare tissue nutrient levels to critical values given in Table 5 to determine if supplemental fertilization is needed.

Table 5. Adequate tissue nutrient concentrations for alfalfa. Concentrations are for whole plant samples (tops) collected at first bloom.

Nutrient	Levels are adequate when greater than:
Phosphorus (P)	0.20 %
Potassium (K)	2.00 %
Sulfur (S)	0.20 %
Magnesium (Mg)	0.30 %
Boron (B)	20 ppm
Manganese (Mn)	15 ppm
Iron (Fe)	40 ppm
Zinc (Zn)	12 ppm
Copper (Cu)	5 ppm
Molybdenum (Mo)	0.8 ppm

Split fertilizer applications. In high yield, long growing season situations, split fertilizer applications may improve alfalfa growth, especially in later cuttings. To prevent luxury consumption, split applications of potassium fertilizer should be considered on low potassium testing soils where high rates of potassium fertilizer will be applied.

Fertigation. Application of liquid fertilizers through the irrigation system is an efficient way to supply nutrients to alfalfa, and allows the grower to easily make in-season applications of all nutrients if desired. Liquid sources of phosphorus, potassium, sulfur, and micronutrients are available in Utah. Carefully compare the cost and convenience of using liquid sources relative to dry fertilizer materials.

Manure and alfalfa. Livestock manures contain large quantities of phosphorus and potassium, and smaller amounts of all other nutrients required by alfalfa. When applied to grain or other crops in a rotation, manure is an efficient way to build soil nutrient levels before reestablishing alfalfa. Manure can also be applied to dormant alfalfa, although lower rates should be used to prevent burning. Manures can increase weed problems in established alfalfa stands by supplying weed seeds and stimulating grassy weed growth.

On-farm testing. Conducting on-farm tests allows the grower to customize management programs for specific situations. On-farm testing can also be used to evaluate new fertility programs. Treat several strips in a field with the new practice and alternate strips with the standard fertility practice. Where possible, try to make several alternating test strips across a field instead of just splitting a field in half and treating each half differently.

Keep records. Alfalfa may respond differently to fertilizer applications across farms due to soil, variety, and other management differences. Keeping individual records of soil and tissue test values, fertilizer applications, and alfalfa yield for each field allows the grower to customize fertility programs for specific situations.

OTHER SOIL MANAGEMENT CONSIDERATIONS

Drainage. Alfalfa will not survive prolonged periods with a saturated root zone. Fine textured soils, and fields with low areas where excess water collects (Figure 4), may be poorly drained and limit alfalfa growth. Improve drainage in these situations by deep tilling or ripping and leveling prior to establishing alfalfa.

Figure 4. Depression in a field where alfalfa died out due to prolonged saturated soil conditions.

Compaction. Compaction limits water infiltration and restricts plant rooting depths. Alfalfa fields are especially prone to compaction due to the large number of mechanical operations required to manage multiple cuttings of hay. In fine textured (silt or clay-dominated) soils, deep tillage or ripping in the rotation prior to reestablishing alfalfa is recommended to treat compaction.

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