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FERTILIZER MANAGEMENT FOR GRASS AND GRASS-LEGUME MIXTURES

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INTRODUCTION

Grass and grass-legume mixtures serve an important role in providing hay and pasture-based forage for livestock in Utah. With proper species selection and favorable irrigation, fertility, and harvest or grazing management, yields of 8 tons/acre or more have been achieved. Management is the key to successful forage production. Supplying the correct amount of nutrients is one important management factor.

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 forage production.* Fertilizer recommendations described in this guide are based on the latest research results from Utah State University trials.

FERTILITY REQUIREMENTS

Grass grown for hay removes large quantities of nitrogen, phosphorus and other nutrients from soil (Table 1). Grass grown for pasture removes lower quantities of nutrients since as much as 85 to 90% of the nutrients consumed in the forage are redeposited on the pasture in the form of manure and urine. Due to the recycling effect of grazing animals the nutrient requirements of pasture differ from the requirements of fields harvested for hay.

Legumes such as alfalfa and clover have the ability to take nitrogen from the atmosphere and convert it into a form usable by plants. Including legumes in mixtures with grass lowers the amount of nitrogen fertilizer required to produce forages.

Fertilizer recommendations for phosphorus, potassium, sulfur and micronutrients are based on current soil test data. In grazed pastures, these nutrient levels remain relatively stable or decline at much slower rates than in hay or field crop situations due to the recycling effect of the livestock. Therefore, once a soil test is completed and the fertilizer applied, retest pastures every three years to monitor nutrient levels. Hay fields should be tested annually.

FERTILIZER RECOMMENDATIONS

Nitrogen. Nitrogen is the main nutrient needed by grass and certain grass-legume mixtures. Both the rate and timing of nitrogen applications will influence the yield, quality and seasonal distribution of forage.

Grass and grass-legume mixtures vary widely in productivity. Utah State University research shows that responses to nitrogen can be as high as 100 pounds of forage produced per pound of nitrogen applied (Figure 1). Many factors govern the productivity of grass and grass-legume mixtures, including soil conditions, irrigation water availability and management, and grazing management. Nitrogen recommendations based on the production potential of the site and the proportion of legume in the stand are summarized in Table 2. It is critical that growers identify the production potential of the site and fertilize according to that potential. Production potential can be estimated by assuming that grass-based forages will be comparable in yield to alfalfa on the site.

Table 1. Average nutrient concentrations and removal by grass hay.

Nutrient	Dry matter concentration	Removal per ton of hay
Nitrogen	2.0 % N	40 lb N
Potassium	3.0 % K_2O	60 lb K_2O
Phosphate	0.65 % P_2O_5	13 lb P_2O_5
Sulfur	0.25 % S	5 lb S

Nitrogen will increase the crude protein content of pure grass and grass-dominated stands. Research has shown that the crude protein content of a grass like tall fescue can be increased from a low of <9% in unfertilized stands to a high of 18% with the application of 150 lb nitrogen/acre. Legumes also significantly improve forage quality.

The seasonal distribution of forage can also be managed with nitrogen applications. Cool season grasses normally have a high rate of production in spring followed by a slowing of growth during the hot summer months. Applying large amounts of nitrogen in early spring will stimulate rapid growth and high yields. If this forage cannot be harvested for hay or grazed, consider postponing the early spring application of nitrogen or fertilizing only part of the field.

Perennial ryegrass response to nitrogen (photo taken in May). The plot on the left received no nitrogen, the plot on the right received 50 lb N/acre in April.

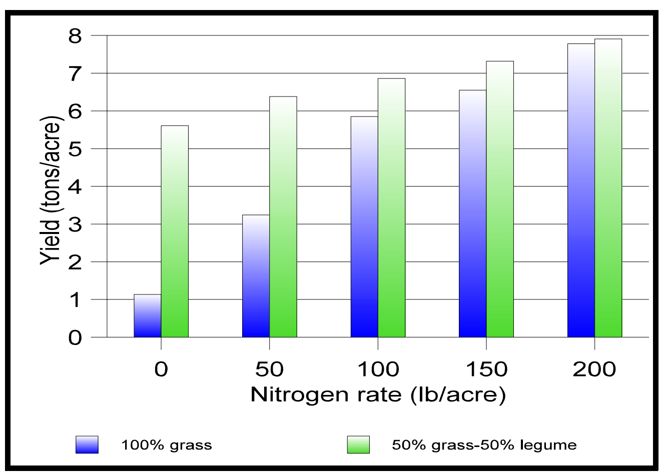

Figure 1. The effect of nitrogen rate on tall fescue and mixed fescue-clover yield.

Table 2. Nitrogen recommendations for irrigated grass and grass-legume mixtures.

	Yield potential of the site			
Stand composition	**1-2 tons/acre**	**2-4 tons/acre**	**4-6 tons/acre**	**6-8 tons/acre**
	---------------- nitrogen recommendation (lbs/acre) ----------------			
100% grass	50	75[1]	100-150[1]	150-200[1]
75% grass, 25% legume	25	50	75-100	100-150[1]
50% grass, 50% legume	0	25	50	75
25% grass, 75% legume	0	0	25	50

[1]For pasture, split the total nitrogen rate into two or three separate applications. Apply 1/3 to 1/2 of the nitrogen in early spring, 1/3 to 1/2 in June, and the remainder in late August. Schedule mid- and late-season nitrogen applications to coincide with irrigation or rainfall events. For hay-pasture systems, apply 2/3 of the nitrogen in early spring and 1/3 after the hay crop is removed to stimulate regrowth for grazing.

Phosphorus. Low phosphorus soils are common in Utah. Research shows that grass and grass-legume mixtures will respond to phosphorus fertilizer applications when soils are deficient. Phosphorus applications also favor legumes and can enhance the proportion of legumes in a mixed stand.

Phosphorus recommendations based on current soil test results are summarized in Table 3. These recommendations are adequate for 2 years of hay production or approximately 4 years of grazed pasture production.

Phosphorus movement in soil is very limited; therefore, where possible apply and incorporate fertilizer prior to pasture establishment. Surface broadcast applications are also effective and should be made in the fall or early spring.

Various sources of phosphorus are available, including triple superphosphate (0-45-0; 45% P_2O_5), monoammonium phosphate (11-52-0; 52% P_2O_5), and fluids such as 10-34-0 (34% P_2O_5). Comparisons indicate that, when applied at the same rate of P_2O_5, the materials are equally effective. Select a phosphorus source based on local availability, ease of application, and cost per unit of P_2O_5.

Table 3. Phosphorus recommendations for grass and grass-legume mixtures. Soil test phosphorus is based on a 12 inch sample depth and sodium bicarbonate soil extract.

Soil test phosphorus (mg/kg soil or ppm)	**Recommendations (lbs P_2O_5/acre)**
0 to 3*	100-125
4 to 7	75-100
8 to 10	50-75
11 to 15	0-50
> 15	0

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

Potassium. Potassium deficiency is less common than phosphorus deficiency, but is frequently found on sandy soils, fields irrigated with clean waters low in potassium, and high elevation sites. Limited research has shown that grass and grass-legume mixtures respond to potassium when soils are deficient. Fertilizer should not be applied unless a soil test indicates a need since fertilizing high potassium soils will produce undesirably high potassium levels in the forage. Potassium recommendations based on current soil test results are summarized in Table 4.

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

A mixed tall fescue-clover stand. Managing the stand with nitrogen or phosphorus can shift the balance to favor either the grass or legume.

Sulfur. In Utah, sulfur deficiency has been identified on sandy, low organic matter soils, fields irrigated with clean waters and high elevation locations. Sulfate-sulfur (SO_4-S) soil test values less than 8 mg/kg soil (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). Elemental sulfur is a slow release form that will last 3 to 4 years. Sulfate forms are more soluble and readily available, but may leach out of the soil in 1 to 2 years. Where sulfur deficiency has been identified, the application of 25 to 50 lbs sulfur/acre is recommended.

Micronutrients. Deficiencies of zinc, iron, copper, manganese and boron are rare in grass and grass-legume mixtures. Soil testing will indicate whether these micronutrients are needed. Soil test interpretations are summarized in Table 5. If soil tests indicate a deficiency, apply 5 (for marginal levels) to 10 (for low levels) lbs of zinc, manganese, or iron, or 1 (for marginal) to 2 (for low) lbs of copper or boron per acre. Sulfate salts are common sources of zinc, manganese, iron, and copper. Sodium borate and boric acid are common sources of boron per acre.

Table 4. Potassium recommendations for grass and grass-legume mixtures. Soil test potassium is based on a 12 inch sample depth and sodium bicarbonate soil extract.

Soil test potassium (mg/kg soil or ppm)	Recommendation (lbs K_2O/acre)
0 to 40*	180-220
40 to 70	140-180
70 to 100	80-120
100 to 150	40-60
> 150	0

*low soil test levels are severely limiting

ADVANCED TECHNIQUES

Fertigation. The application of liquid fertilizers through the irrigation system is an efficient way to supply nutrients, and allows growers to make in-season or split applications if desired. Liquid sources of most nutrients are available. Carefully compare the cost and convenience of using liquid sources relative to dry fertilizer materials.

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

Table 5. Micronutrient soil test values (mg/kg soil or ppm) and interpretations.*

Nutrient	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; hot water extractable boron.

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

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