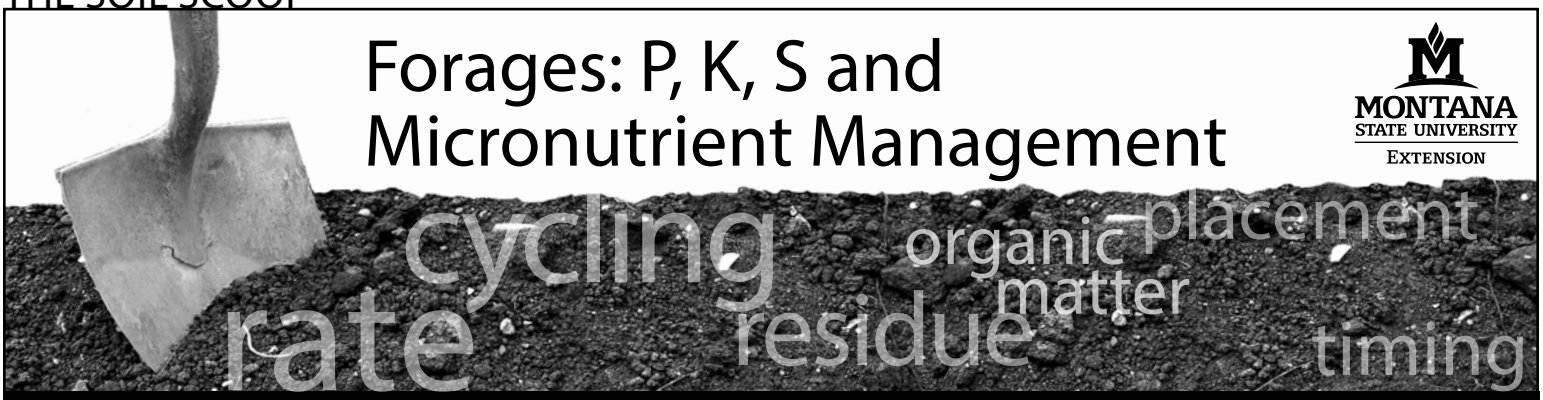
Forages: P, K, S and Micronutrient Management



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An important step towards soil fertility is nurturing soil health to improve plant resistance to stress and increase yields. In forage production, adequate plant recovery time, plant species diversity, cover and standing material to buffer changes in soil temperature and help store water, and sound fertilizer management contribute to soil health. However, phosphorus (P), potassium (K), sulfur (S) and micronutrients are reduced in a field by harvest, erosion, binding to form minerals, or leaching and need to be added to the soil. This Soil Scoop is a synopsis of *Soil Nutrient Management for Forages: P, K, S, and Micronutrients*. See the full bulletin for more details.

The key to fertilizing for optimal forage yield and quality is to select the right fertilizer source, rate, placement, and timing.

SOURCE Nutrient sources that need to be decomposed or broken down in the soil to become plant available (e.g., rock phosphate, elemental sulfur, or manure) will have a lag effect between application and forage response. They may provide nutrients too late to promote early spring growth, but can extend benefits for season-long forage or a late cutting.

Elemental S reduces soil pH which may inhibit legume N-fixation. It should not be used in fields with- or intended for legumes if soil pH in the upper 6 inches is less than 6.5.

Readily soluble fertilizers (e.g., potassium sulfate) are more easily lost from soil than others, while phosphate fertilizers can become tied up as minerals which are minimally plant available. See EB0188 for information on specialized P fertilizers.

If available, manure may be the most economical P and K source. Test the manure and soil for nutrient content to calculate application rates that meet crop needs. Manure may contain more P and K than grass needs annually and can be used to bank P and K in the soil. However, the high N concentration may reduce N fixation in legumes and manure can contain herbicide residues toxic to forage species.

DETERMINING RATE Use soil tests of the top 6 inches to determine P and K rates. It is especially important to base K fertilization rates on soil tests. Low K levels can reduce N fixation in legumes and cause a legume-grass field to quickly convert to mostly grass. High soil K levels can lead to high K concentration in forage which increases the risk of milk fever.

Sulfate-S soil tests are not a reliable indicator of plant available S. Plant tissue analysis can be used for in-season management of S and other nutrients. For example, if hay appears N deficient or has lower than expected protein, it may actually be S deficient and unable to use available N. This would show up in tissue analysis. EB0217 provides tissue analysis guidelines. However, tissue concentrations should only be used in combination with field history and/or crop appearance to make S and micronutrient fertilizer rate recommendations.

Visual plant deficiency symptoms can indicate nutrient deficiencies, yet, once nutrient deficiency symptoms appear, yield potential has likely been reduced. Also, plant symptoms may be an indicator of environmental stress, that can't be helped with additional fertilizer. See 4449-9 for deficiency and toxicity symptoms.

RATE Tables 1 and 2 provided guidelines for P and K fertilizing of established stands. Forage is most likely to respond to additional P when soil levels are low.

Prior to seeding new stands, apply 3 to 4 times the P and K rate suggested based on soil tests to supply plants for several years. If soil P is low, 10 lb P_2O_5/acre at the time of seeding can significantly increase seedling establishment. Due to the risk of seedling damage, place no more than 20 lb P_2O_5/acre, or 10 to 15 lb N + K_2O/acre in the seed band. Higher rates may be banded below and to the side of the seed.

A 10 to 20 lb S/acre in-season application of sulfate-S can alleviate S deficiency for legume-grass mixtures. Cereal hay in high N production systems can benefit from 20 lb S/acre to keep forage nitrate levels below those toxic to non-pregnant livestock. Alfalfa requires more S than grass.

The addition of 25 lb S/acre to a single application of 50-100-50 lb NPK/acre on dryland alfalfa and alfalfa-grass produces higher protein levels for several years than if S is omitted from the fertilizer mix. Applications of 45 lb S/acre may be needed to sustain high alfalfa yields and protein in high production systems.

Extreme care is required when applying micronutrients because some (especially boron) can be toxic. Refer to EB0217 for guidelines.

TIMING Phosphorus and K are best mixed into the soil before seeding. On established stands, apply P after the last cutting or in fall when roots are storing carbohydrates. Potassium is best split between the first and last cuttings to ensure the first harvest does not take up more than it needs and to promote good stand health going into winter. Fertilizers that supply readily available mobile nutrients (e.g., sulfate) should be applied shortly after green-up.

PLACEMENT Phosphorus is most effective placed in the root zone, especially when the soil is very P deficient, under moisture limited conditions, or at low P application rates. Sub surface applications can be disruptive to the stand. Surface applications may be better under irrigation. Placement of K is less important.

Foliar application is useful for in-season adjustment of nutrients if leaf burn is minimized. Foliar P is more beneficial in low than high yielding years, but does not produce higher yields than broadcast P under irrigation.

Foliar application of iron (Fe), copper (Cu), manganese (Mn), or zinc (Zn) may be a practical and economical way to correct in-season deficiency. See EB0217 Table 7 for guidelines.

ECONOMICS Phosphorus and K can be added when fertilizer prices are lower and banked in the soil for later use. Test strips are valuable to gauge forage nutrient response before investing in fertilizing a whole field. Improving and maintaining forage stands with fertilizer is effective and less expensive than mechanical treatments to improve yields and quality. However, fertilizing stands that have more undesirable than desirable species may increase production of the undesirable species.

For more information:

Enhanced Efficiency Fertilizers EB0188

Fertilizer Guidelines for Montana Crops EB0161

Plant Nutrient Functions and Deficiency and Toxicity Symptoms, Nutrient Management Module 9 4449-9

Soil Nutrient Management for Forages: P, K, S and Micronutrients EB0217

Available under "Extension publications" at http://landresources.montana.edu/soilfertility/ or at MSU Extension Publications, (406) 994-3273, http://msuextension.org/store.

Table 1. Phosphorus fertilizer guidelines for alfalfa and grass in Montana based on soil analysis[1].

Crop	Olsen P Soil Test Level (ppm)				
	0	4	8	12	16[2]
	P Fertilizer Rate (lb P_2O_5/acre)				
Alfalfa	140	110	75	40	20[3]
50/50 Alfalfa/grass	93	73	53	30	13
Grass	45	35	30	20	5

1. From EB0161
2. If soil test is above 16 ppm, then use removal rate (Table 21 in EB0161).
3. This was printed as 0 in the original, which is an apparent error.

Table 2. Potassium fertilizer guidelines for alfalfa and grass in Montana based on soil analysis[1].

Crop	K Soil Test Level (ppm)					
	0	50	100	150	200	250[2]
	K Fertilizer Rate (lb K_2O/acre)					
Alfalfa	240	205	170	140	95	30
50/ 50 Alfalfa/grass	160	137	115	93	63	23
Grass	80	70	60	45	30	15

1. From EB0161
2. If soil test is above 250 ppm, then use removal rate (Table 21 in EB0161)

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