



# SOIL

## Fertilizing Alfalfa and Grasses

no. 0.537

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### Quick Facts...

Phosphorus is the most limiting nutrient for alfalfa production.

Apply phosphate fertilizers for establishing new stands at rates based on soil test results. Incorporate broadcast applications of phosphate fertilizers into the soil prior to seeding.

Apply nitrogen fertilizers for establishing new stands of irrigated forage crops and annual applications for perennial grasses at rates based on  $\text{NO}_3\text{-N}$  levels in the soil.

Most Colorado soils contain sufficient available potassium and sulfur for forage production.

Adequate soil fertility is one of the requirements for profitable forage production. Alfalfa is the most productive of the forages. It is moderately tolerant of soil salinity, but should not be planted on soils with a salinity greater than 5 decisiemens per meter (dS/m), which is equivalent to the same value in millimhos/cm.

Alfalfa biologically fixes nitrogen (N) from the air, so N fertilizers generally are required only for new seedlings during early establishment. If a companion crop is used for establishing a new stand, some fertilizer N may be required if soil levels of  $\text{NO}_3\text{-N}$  are low.

Phosphorus (P) generally is the most limiting nutrient for alfalfa production, while potassium (K) usually is not limiting in Colorado soils. Before establishing a stand, soils should be tested to determine the soil fertility status so appropriate fertilizers can be applied and properly incorporated.

For more information on fertility requirements and cultural practices for alfalfa, refer to fact sheet 0.703, *Alfalfa: Production and Management*.

### Soil Sampling

The value of a soil test in predicting nutrient availability during the growing season is directly related to how well the soil sample collected represents the area sampled. Take soil samples prior to seedling establishment so P fertilizers may be incorporated into the soil.

For established stands, sample in the early fall so P fertilizers can be topdressed prior to winter. Take surface samples from the 1-foot soil depth. A good sample is a composite of 15 to 20 soil cores taken from randomly selected sites across a uniform soil type. Sample separately areas with major differences in soil properties or management practices.

Thoroughly dry all soil samples within 12 hours after sampling by spreading the soil on clean paper or any other clean surface where the soil will not be contaminated. **Do not oven dry the soil** because this will change the soil test results. Ship the air-dried soil in a clean sample container to the soil test laboratory.

Submit a carefully completed information sheet with the soil sample. This form provides information so fertilizer application suggestions can be tailored to each specific situation. For existing stands, periodically test soils for nutrient analysis for optimum P nutrition.

More detailed explanations of the importance of taking proper soil samples are found in 0.500, *Soil Sampling*, 0.501, *Soil Testing*, and 0.502, *Soil Test Explanation*. These fact sheets are available at your Colorado State University County Extension office or from the Cooperative Extension Resource Center, 115 General Services Building, Colorado State University, Fort Collins, CO 80523; (970) 491-6198.

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**Table 1: Suggested N rates for new seedings of irrigated alfalfa.**

ppm NO <sub>3</sub> -N in soil	Companion crop:	
	With	Without
	Fertilizer rate, lb N/A	
0 - 3	60	20
4 - 6	30	10
> 6	0	0

New seedings of dryland alfalfa generally do not benefit from preplant N.

NOTE: Nitrogen fertilizers should not be applied to established stands of alfalfa. N fixation activity can be decreased.

**Table 2: Suggested N rates for irrigated grasses.**

ppm NO <sub>3</sub> -N in soil	Fertilizer rate, lb N/A
0 - 6	185
7 - 12	160
13 - 18	135
19 - 24	110
25 - 30	85
> 30	0

NOTE: Use the same N rates for grass-legume mixtures containing less than 25 percent legumes.

**Table 3: Suggested P rates for irrigated alfalfa.**

ppm P in soil		Relative level	Fertilizer rate, lb P <sub>2</sub> O <sub>5</sub> /A	
AB-DTPA	NaHCO <sub>3</sub>		New seedings	Established stands*
0 - 3	0 - 6	very low	200	100
4 - 7	7 - 14	low	150	75
8 - 11	15 - 22	medium	50	0
> 11	> 22	high	0	0

\*Suggested P rates for established stands should be based on new soil test results.

**Table 4: Suggested P rates for irrigated grasses, grass-legume mixtures and pastures.**

ppm P in soil		Relative level	Fertilizer rate, lb P <sub>2</sub> O <sub>5</sub> /A	
AB-DTPA	NaHCO <sub>3</sub>		New seedings	Established stands*
0 - 3	0 - 6	low	80	80
4 - 7	7 - 14	medium	40	40
> 7	> 14	high	0	0

\*Suggested P rates for established stands should be based on new soil test results.

**Table 5: Suggested P rates for dryland alfalfa.**

ppm P in soil		Relative level	Fertilizer rate, lb P <sub>2</sub> O <sub>5</sub> /A	
AB-DTPA	NaHCO <sub>3</sub>		New seedings	Established stands*
0 - 3	0 - 6	low	60	45
4 - 7	7 - 14	medium	45	30
> 7	> 14	high	0	0

\*Suggested P rates for established stands should be based on new soil test results.

NOTE: Phosphorus applications are not recommended for grass-legume mixtures and grass forages produced under dryland conditions.

The Colorado State University Soil, Water and Plant Testing Laboratory is located in Room A319, Natural and Environmental Sciences Building, Colorado State University, Fort Collins, CO 80523; (970) 491-5061.

## Nitrogen Suggestions

Because legumes usually fix N from the atmosphere, some of their N requirements are met through this process. Inoculate alfalfa with specific host bacteria if alfalfa has not been grown recently in a field. However, some preplant N may be needed for the companion crop in the establishment of alfalfa under irrigated conditions if residual NO<sub>3</sub>-N levels in the soil are low (Table 1). Decrease the seeding rate of the companion crop and do not overapply N to avoid shading of the new alfalfa and grass seedlings.

Preplant N fertilizers generally are applied broadcast and incorporated in combination with P fertilizers. Application of N fertilizers in the establishment of alfalfa is not suggested under dryland conditions.

Grasses require annual N applications. The suggested N rate is related to the NO<sub>3</sub>-N status of the soil. Nitrogen application can increase yields of grass-legume mixtures, but also results in a decline of the legume component. Therefore, application of N to mixtures comprised of more than 50 percent of the legume component is not recommended. Generally, the proportion of legume will decline with time. Once this proportion reaches 25 percent or less, stands should be fertilized with N according to the same recommendations given for grasses alone (Table 2). Suggested N rates in Table 2 are for an expected yield of 4 tons per acre. These rates should be adjusted by 40 lb N/A for each ton/A difference in expected yield.

## Phosphorus Suggestions

### Irrigated Alfalfa

Alfalfa responses to applied P are most likely on soils with low or medium levels of extractable P. Suggested P rates (Table 3) are based on broadcast applications related to soil test levels. The main soil tests for extractable P in Colorado soils are the AB-DTPA and sodium bicarbonate (NaHCO<sub>3</sub>) tests. Values for both tests are in Table 3.

### Irrigated Grass and Grass-legume Mixtures

Table 4 gives suggested P rates for establishment of irrigated grass and grass-legume mixtures for forage production. Broadcast and incorporate phosphate fertilizers into the soil prior to seeding.

## Other Nutrients

Most Colorado soils contain adequate levels of available S, and soil tests for available S are not routinely performed. Alfalfa has a high S requirement; a 4-ton/A crop removes 20 lb of S/A. Therefore, levels of available S may decrease, especially on soils low in organic matter. Irrigation water from most surface waters and some wells often contains appreciable  $SO_4$ -S, so irrigated soils usually are adequately supplied with S. However, some well waters as well as snow-melt water are low in  $SO_4$ -S, so water samples should be analyzed if soils are low in organic matter and S deficiency is suspected.

There have been no confirmed deficiencies of boron (B), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) in alfalfa, perennial grasses, and grass-legume mixtures for forage production in Colorado.

## Dryland Alfalfa

Alfalfa responses to applied P under dryland conditions are most likely on soils with low or medium levels of extractable P. Suggested P rates (Table 5) are based on broadcast applications related to soil test levels.

## Phosphorus Fertilizer Placement

Placement of P fertilizers in the root zone is important because P is not mobile in soil. Broadcast application followed by incorporation prior to planting is the most efficient placement method for P, and the suggested rates for new seedlings in Tables 3 to 5 are for three years of forage production.

Established stands that will be maintained more than three years may need topdressing of phosphate fertilizer. Test soils in early fall, so P fertilizers can be applied prior to winter if needed. While P does not move in soil under most conditions, phosphate fertilizers may be washed into cracks in the dry soil during the fall and spring, or be incorporated by freezing and thawing during the winter. Branch roots near the soil surface also may take up applied fertilizer P.

The last cutting in the fall should be early enough so there is sufficient regrowth to reduce the potential for erosion of P-fertilized soils during the fall and winter months. Base application rates of P fertilizers on new soil test levels, but apply about half of the rates suggested for establishing stands. Two important factors should be considered in managing P fertility in established stands of alfalfa. First, the probability of forage response to topdressed P is greater on soils testing very low to low in extractable P. Second, the probability of obtaining a yield response to topdressed P declines as the stands age.

Most P fertilizers contain N that may not be needed by the alfalfa, except during stand establishment. However, few alternate P sources are available. Choose a fertilizer based on availability and cost per unit of P.

**Table 6: Suggested K rates for irrigated alfalfa, grass-legume mixtures and perennial grasses.**

ppm K in soil AB-DTPA or $NH_4OAc$	Relative level	Fertilizer rate, lb $K_2O/A$	
		Alfalfa	Grass-legume
0 - 60	low	200	60
61 - 120	medium	100	40
> 120	high	0	0

Suggested rates are for 3 years of production.

**Table 7: Suggested K rates for dryland alfalfa.**

ppm K in soil AB-DTPA or $NH_4OAc$	Relative level	Fertilizer rate, lb $K_2O/A$	
		New seedlings*	Established stands**
0 - 60	low	45	30
> 60	high	0	0

\*Suggested rates are for 3 years of production.

\*\*Suggested rates are for 1 year of production.

NOTE: Potassium applications are not suggested for grasses and grass-legume mixtures under dryland conditions.

## Potassium Suggestions

### Irrigated Alfalfa and Grass-Legume Mixtures

Most Colorado soils are relatively high in extractable K, and few crop responses to K fertilizers have been reported. Suggested K rates related to soil test values for three years of production of alfalfa and grass-legume mixtures under irrigated conditions are in Table 6.

The main K fertilizer is KCl (potash). Broadcast application incorporated into the soil prior to planting is the usual method of application. Potassium fertilizers can be topdressed on established stands to help maintain stands.

### Dryland Alfalfa

Under dryland conditions, the suggested K rates in Table 7 for new seedlings are for three years of production, but those for established stands are for the current year. Potassium fertilizer applications are not suggested for grass and grass-legume mixture forage production under dryland conditions.

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