Southern Idaho Fertilizer Guide

Irrigated Alfalfa

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The following fertilizer recommendations are based on university and USDA-ARS research that relates crop yield response to nutrient application rates at different soil test values. The recommendations are designed to produce above average yields if other environmental or cultural factors are not limiting. Good crop management is assumed.

The suggested fertilizer rates also assume that soil samples are properly collected, processed, and analyzed, and that they represent the areas to be fertilized. Many fields have appreciable variation in residual soil fertility and potential productivity. Areas within fields that differ appreciably should be sampled and fertilized separately if they are large enough to allow nutrient application rates to be conveniently adjusted and if the differential application would be cost effective.

Precision ag technology and variable rate applicators currently provide options for differentially fertilizing field areas. For information on mapping soil nutrient concentrations and variably applying fertilizer, contact an extension soil fertility specialist, your local county extension educator, or reputable fertilizer dealers/consultants.

Soil Sampling

Representative soil samples are essential. Each soil sample submitted to a soil test laboratory should consist of a composite of at least 20 individual cores from within the area of interest. Collect separate samples from the 0- to 12-inch and 12- to 24-inch depths. Skip areas that represent only a small portion of the field such as gravelly areas, saline or sodic areas, wet spots, and turn rows.

Do not store moist samples under warm conditions because microbial activity can change the extractable N in the sample. Samples that are not air-dried should be sent to the laboratory as quickly as possible.

Fertilizer Recommendations

Nutrient requirements for alfalfa are relatively high compared to many other crops commonly grown in Idaho. Each ton of alfalfa hay removes about 60 lb nitrogen (N) per acre, 50 lb potassium (K) per acre, 30 lb calcium (Ca) per acre, 8 lb phosphorus (P) per acre, and about 6 lb per acre of both sulfur (S) and magnesium (Mg). Requirements for phosphorus and potassium fertilizers are much higher than for S, manganese (Mn), zinc (Zn), iron (Fe), and boron (B).

Nitrogen

Essentially all N required by established alfalfa is provided by the symbiotic relationship with N-fixing Rhizobium bacteria and N mineralized from soil organic matter. Topdressed N usually does not improve yield, quality, or vigor of established stands. However, applications of 20 to 40 lb N per acre may be helpful during stand establishment prior to nodulation of the roots. Applied N would most likely be needed following small grain production in which the residue is returned to the soil. Application of larger amounts may inhibit nodulation, decrease symbiotic N fixation, and encourage grass weeds, thereby reducing alfalfa growth or quality when harvested. Alfalfa receiving appreciable amounts of animal manures, dairy effluent, or other organic N sources will also have reduced N fixation. The probability of an N response is usually greatest on coarse-textured soils with low organic matter content.

Nitrogen fertilizer may be required for maximum alfalfa production and quality if the roots are poorly nodulated. Poor nodulation as well as poor Rhizobial activity and N-fixing capacity can result from a number of factors, including lack of proper seed

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inoculation at planting, diseases, insects, water deficits, nutrient deficiencies or toxicities, or other soil physical or chemical conditions that reduce the effectiveness of the Rhizobium inoculant. Poor inoculation results from not using inoculant, using inoculant that has lost its viability (expired shelf life), or using Rhizobium inoculant strains that are not effective. Poor inoculation, nodulation, or Rhyzobial effectiveness is indicated when alfalfa protein is low (less than 18%) when cut at the early bloom stage. Healthy Rhizobium nodules should be pink when cut open if they are effectively fixing atmospheric N.

If nodulation or Rhyzobial effectiveness is limited by pests, water deficits, or soil conditions such as salinity, sodicity, nutrient deficiencies, or soil compaction, then attempts should be made to correct the problem through appropriate management practices. For more information on proper inoculation of alfalfa, refer to CIS 838 *Inoculation of Legumes in Idaho*.

Alfalfa is sometimes used to scavenge nutrients from soils receiving excessive animal manure or other biological waste applications. An alfalfa crop yielding 6 tons per acre can remove up to 360 lb of N per acre. However, excessive nitrogen uptake can increase the forage nitrate toxicity hazard for dairy and beef cattle. In addition, animal manure applications can promote grass and weed growth, which in turn can also increase the potential for nitrate toxicity if the population of the noxious weed Kochia increases.

Producers sometimes plant a companion crop when establishing alfalfa in order to increase the productivity of the first cutting. However, this practice is not recommended because the alfalfa stand typically is reduced by competition from the companion crop. If growers plant alfalfa with a companion crop, both crops compete for the available N. Under these conditions, N rates of 30 to 40 lb per acre are suggested if available soil N does not exceed 60 to 80 lb per acre.

Phosphorus

Adequate P availability is important for maintaining plant health, winterhardiness, and optimum root, stem, and leaf growth. Since phosphorus is relatively immobile in soil, P fertilizer should be incorporated into the soil prior to planting to raise soil P concentrations to optimum levels for early plant growth. The phosphorus recommendations presented in Table 1 are based on the soil test P concentration and free lime content in the top foot of soil, and the yield potential. Significant amounts of free lime in the soil will make less phosphorus available to plants as it precipitates soil solution P.

Table 1. Recommended P fertilization rates for irrigated alfalfa based on soil test P and free lime content.

Soil test P[1] (0 to 12 inch)	Free Lime Content (%) 0	4	8	12
ppm P	------------P_2O_5 (lb/acre)-----------			
0	300	340	380	420
3	250	290	330	370
6	200	240	280	320
9	150	190	230	270
12	100	140	180	220
15	50	90	130	170
18	0	40	80	120
21	0	0	30	70

[1]$NaHCO_3$ extraction

NOTE: Add 10 lb P_2O_5 per acre for each 1 ton per acre increase in yield goal above 6 tons per acre.

Topdressed P applications can also be effective but should be made following harvest in the fall or in the spring before regrowth in order to maximize soil contact. Knifing ammonium polyphosphate (10-34-0) into the soil or applying surface bands in the fall or spring are also effective P fertilization methods for alfalfa.

As the stand ages and plant density decreases, the ability of the alfalfa root system to take up P diminishes due to decreased soil P concentrations and root activity. Under these conditions, smaller P rates applied more frequently may increase P uptake efficiency.

Effective sources of P for alfalfa include monoammonium phosphate (11-52-0), triple superphosphate (0-45-0), ammonium polyphosphate (10-34-0), and phosphoric acid. Fertilizer P can be broadcast as 11-52-0 or applied through the irrigation system as 10-34-0 with equal effectiveness. Phosphorus sources should be selected on the basis of cost, local availability, and equipment requirements.

Potassium

Alfalfa has a high K requirement. A crop of 8 tons per acre will remove about 480 lb of K_2O per acre. Most Idaho soils and surface irrigation waters are naturally high in K. However, K deficiencies can develop in intensively cropped fields, particularly those fields cropped to alfalfa for many years. Sandy soils are generally more prone to developing K deficiencies than silt loam or clay soils and therefore have a higher probability of responding to K fertilization.

Potassium movement in soils is limited, although it is more mobile than P. Like phosphorus, potassium fertilizer recommendations are based on calibrated relationships between soil test concentrations in the top foot of soil and yield response (Table 2). Soil test K should generally be in the range of 160 to 200 ppm for optimum alfalfa yield. Potassium fertilizer should also be incorporated during seedbed preparation prior to establishment, or broadcast in the fall or early spring on established stands. Potassium chloride (0-0-60), potassium sulfate (0-0-52), K-Mag, and various liquid K fertilizers are all effective K sources for alfalfa.

Table 2. Recommended K fertilization rates for irrigated alfalfa based on soil test K concentrations and yield goal.

Soil test K[1] (0 to 12 inch)	Yield goal (tons/acre) 6	7	8	9
ppm	K application rate (lb K_20/acre)			
0	240	300	360	420
40	180	240	300	360
80	120	180	240	300
120	60	120	180	240
160	0	60	120	180
200	0	0	60	120
240	0	0	0	60

[1]$NaHCO_3$ extraction

Potassium applications exceeding 300 lb K_2O per acre should be split between fall and spring to avoid salt damage. Excessive K applications should be avoided since alfalfa will remove substantially more K than it needs for maximum yield. Excessive K concentrations in alfalfa can contribute to milk fever in dairy cattle.

Sulfur

Sulfur is a key contributor to alfalfa yield and quality. Sulfur requirements for alfalfa vary with soil texture, leaching losses, soil test SO_4-S concentration, and S content of the irrigation water. About 30 to 40 lb of SO_4-S should be applied before planting to soils containing less than 10ppm SO_4-S in the top foot of soil. This amount should provide adequate soil S for several years, provided the SO_4-S is not leached from the rooting depth. The SO_4-S form is mobile and can be leached to lower soil profile depths. For established alfalfa, sampling to a depth of two feet will provide a more accurate indication of S availability to alfalfa roots beyond the first foot.

Areas irrigated with water from the Snake River or streams fed by return flow should have adequate S for alfalfa production. High rainfall areas, mountain valleys, and foothills are more likely to have S deficiencies, particularly on course-textured soils with low organic matter content.

Sulfur fertilizer sources should be carefully selected because elemental S must be converted to SO_4-S by soil microorganisms before plant roots can take it up. Conversion of elemental S to SO_4-S may take several months in warm, moist soil. Consequently, elemental S fertilizers usually cannot supply adequate levels of S to alfalfa in the year that it is applied. However, elemental S fertilizers can supply considerable S during the year following application. Sulfate-sulfur sources such as gypsum (calcium sulfate), ammonium sulfate (21-0-0), or potassium sulfate (0-0-52-18) are recommended to correct S deficiencies during the year of application.

Secondary Nutrients and Micronutrients

Calcium and magnesium deficiencies in alfalfa are rare in the irrigated areas of southern Idaho. Most soils in the Snake River plain have adequate amounts of Ca and Mg for alfalfa production, although low soil Mg concentrations are sometimes encountered on very sandy soils that have been heavily fertilized with K for long periods. Under these conditions, applications of $MgSO_4$ or K-Mag at 20 to 40 lb of Mg per acre may provide a benefit.

Micronutrient applications should be based on recent soil test results (Table 3). Boron deficiencies can usually be corrected by applying 2 to 3 lb of B per acre for the duration of the crop. However, on very sandy soils, or high rainfall areas where soils are subject to excessive leaching of B, annual applications of 1/2 to 1 lb of B per acre may be more effective. Commonly used forms of B include boric acid, Borax, and sodium borate.

Zinc, Mn, and Fe deficiencies can be corrected by applying 5 to 10 lb per acre of the required nutrient using Zn, Mn, or Fe sulfates or other soluble forms. Molybdenum availability is generally adequate in the alkaline soils that are prevalent in the irrigated areas of southern Idaho.

Table 3. Adequate soil test micronutrient concentrations for alfalfa.

Nutrient	Adequate concentration (ppm)[1]
Boron	> 0.5
Zinc	> 1.0
Manganese	> 1.0
Iron	> 5.0

[1]DTPA extractable zinc, manganese, and iron

Table 4. Sufficiency ranges for alfalfa stem tissue sampled at early bloom.

Nutrient	Sufficiency range
	------%------
Nitrogen	3.00-5.00
Phosphorus	0.25-0.75
Potassium	2.50-4.00
Calcium	0.50-3.00
Magnesium	0.30-1.00
Sulfur	0.25-0.50
	----ppm---
Boron	30-80
Zinc	20-70
Manganese	30-100
Iron	30-150
Copper	5-25
Molybdenum	1-5

Tissue Testing

Plant tissue testing provides an effective means of evaluating the nutrient status of an established alfalfa stand. Samples should be collected from about 20 to 30 plants at early bloom in representative areas of the field that are free from water stress or obvious pest problems. The top six inches of the stem should be sampled and sent immediately to a soil testing lab for analysis. Sufficiency ranges for the various nutrients are presented in Table 4. Nutrient concentrations below these ranges indicate a need for supplemental fertilization.

When nutrient deficiencies are identified during the growing season, the deficiencies can often be corrected by injecting water-soluble fertilizers through the sprinkler system. Liquid forms of N, P, K, S, and micronutrients are commonly available in Idaho and should be selected on the basis of cost relative to dry fertilizers and ease of application. If alfalfa is furrow irrigated, foliar sprays can be used to correct micronutrient deficiencies but avoid foliar applications of N, P, K, and S at high rates that can cause foliar burning.

For Further Reading

You may order this and other publications about fertilizers and crops in southern Idaho from the University of Idaho Cooperative Extension offices in your county or Ag Publications, P.O. Box 442240, University of Idaho, Moscow, ID 83844-2240, phone (208) 885-7982, fax (208) 885-7982, email *agpub@uidaho.edu*, or *http://info.ag.uidaho.edu* on the internet.

CIS 838 *Inoculation of Legumes in Idaho, $0.35*

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