Southern Idaho Fertilizer Guide

Irrigated Alfalfa Seed

Brad Brown and Jim Barbour

The following estimated fertilizer recommendations for irrigated alfalfa seed are based on the nutrient requirements for alfalfa forage but modified based on important differences in alfalfa seed cultural practices. Considerable research conducted by land-grant universities in the western states and the USDA-ARS has established relationships between alfalfa forage crop yield and nutrient application rates at different soil test values. Considerably less research has been done on the nutrient requirements of alfalfa produced for seed. Differences in the production practices used for irrigated alfalfa seed and forage production have significant implications for satisfying the crop's nutrient requirements.

Biomass Production and Removal—Forage alfalfa vegetative biomass is removed three to four times a season in southwestern Idaho. In contrast, less than 15 percent of the mature plant biomass is removed in a single seed harvest. Consequently, irrigated alfalfa seed production involves much less nutrient removal than harvest of forage alfalfa.

All non-seed biomass is returned to the soil after the harvest of alfalfa seed. In some cases, a portion of the non-seed residue is burned. Early season biomass is less critical for seed production. Biomass is frequently flailed in the spring to delay development and bloom until such time as pollinators are more active.

Plant Population—Forage production is derived from uniform stands established from drilling or broadcasting seed to maximize vegetative biomass. In contrast, seed production involves planting the seed in wider spaced rows (typically 22-inch spacing) that are thinned to minimize the canopy cover and facilitate pollinator access to flowers. Thinner populations result in larger root masses per plant and nutrient acquisition from greater soil volumes.

Watering—Forage alfalfa is watered and fertilized to maximize biomass production. With seed production the crop may be stressed intentionally to induce bloom and then watered less during the remainder of the season to avoid excessive vegetative growth that may adversely affect pollinator visitation. Excessive fertilization is also avoided to minimize vegetative growth that may interfere with flowering, pollination, and seed production.

Residue Burning—Alfalfa seed residues are sometimes burned to help control seed feeding chalcids that overwinter in the residue. Most nutrients, such as phosphorus (P) and potassium (K), remain with the ash. Significant nitrogen (N) in the residue is lost with burning, but this N is probably not critical for alfalfa seed production as the plant can fix atmospheric N when moisture conditions allow.

Recommendations and Assumptions—The recommendations are designed to produce above average yields if other environmental or cultural factors do not limit production. Thus, good crop management is assumed. The suggested fertilizer rates also assume that soil samples are properly collected, processed, and analyzed and are representative of the areas to be fertilized.

Many fields have areas that vary appreciably in residual soil fertility and yield. Such areas should be sampled and fertilized separately if they are large enough to allow nutrient application rates to be conveniently adjusted and applied cost effectively.

Recent advances in site-specific nutrient mapping and variable rate fertilization provide improved options for differentially fertilizing field areas. For information on mapping soil nutrient concentrations and variably applying fertilizer, contact the extension soil fertility specialist, local county ag extension edu-

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CIS 1116

cators, or fertilizer dealers/consultants. The publication, *Monitoring Soil Nutrients Using a Management Unit Approach,* PNW 570, may also be useful.

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 areas of similar soil type. Separate samples should be collected from the 0 to 12-inch and 12- to 24-inch depths in each area. Samples should not be collected from areas that do not represent the majority of the field, such as gravelly, saline, or sodic areas, wet spots, and turn rows.

Moist soil samples should be stored under refrigerated conditions because microbial activity can change the extractable nitrogen concentration in the sample. Samples should be sent to the laboratory as quickly as possible if they are not air-dried.

Fertilizer Recommendations

Nitrogen

Essentially all N required by established alfalfa is provided by the symbiotic relationship with N-fixing rhizobium bacteria, from residual N, and N mineralized from soil organic matter. Topdressed N usually does not improve seed yield. However, applications of 20 to 40 pounds N per acre may be helpful during stand establishment before nodulation of the roots. The applied N would most likely be needed after small grains when significant amounts of residue are returned to the soil.

Application of larger amounts of N may inhibit nodulation and reduce symbiotic N fixation. Application of manures, dairy effluent, or other organic N sources may also reduce nodulation and N fixation. The probability of an N response is usually greatest on coarse-textured soils with low organic matter content, low residual soil N concentrations, and small grain or corn residues returned to the soil.

Poor nodulation results from improper seed inoculation at planting, diseases, water deficits, or 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 ineffective rhizobium inoculant strains.

Poor inoculation is indicated when alfalfa N content is low (less than 2.9%) at the early bloom stage. Nodules that are effective in fixing atmospheric N are typically pink or dark red when cut open.

Rhizobium activity and N fixing capacity can also be reduced when plants are weakened from diseases, insect feeding, drought, and nutrient deficiencies or toxicities. If pests or soil conditions, such as salinity, sodicity, nutrient deficiencies, soil compaction, or water deficits, are limiting nodulation, then attempts should be made to correct the problem through appropriate management practices. For more information on proper inoculation of alfalfa refer to *Inoculation of Legumes in Idaho,* CIS 838.

Phosphorus

Adequate P is important for maintaining optimum root, stem and leaf growth, reducing disease susceptibility, and developing good winter-hardiness. But excessive P may reduce seed yield if the alfalfa lodges, or increased vegetative growth reduces pollinator access to the bloom. There are many reports of added P increasing forage alfalfa yield, but added P has seldom increased seed yield in research trials.

Phosphorus is relatively immobile in soil and should be incorporated for maximum uptake efficiency. As a result, it is important to incorporate P fertilizer into the soil before planting to raise soil P concentrations to optimum levels for normal plant growth. The phosphorus recommendations presented in Table 1 are based on the soil test P concentration and free lime content at the 0 to 12-inch depth. Significant amounts of free lime in soil precipitates soil solution P making it less available to plants.

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

Soil test P* (0-12 inches)	Free lime content (%) 0	4	8	12
(ppm)	—————— P_2O_5 (lb/acre) ——————			
0	200	240	280	320
3	150	190	230	270
6	100	140	180	220
9	50	90	130	170
12	0	40	80	120

*Sodium bicarbonate extraction

Topdressed P applications can also be effective but should be made after harvest in late summer, or in the spring before cross cultivation. 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.

Monoammonium phosphate (11-52-0), triple superphosphate (0-45-0), ammonium polyphosphate (10-34-0), and phosphoric acid are all effective P sources for alfalfa. Direct comparisons of broadcast 11-52-0 and water run 10-34-0 showed that they are equally effective sources of P for alfalfa. Phosphorus sources should be selected on the basis of cost, local availability, and equipment requirements.

Potassium

Alfalfa seed has a low to moderate K requirement. Most Idaho soils and surface irrigation waters are naturally high in K. However, K deficiencies can develop in intensively cropped fields not fertilized with K for extended periods. 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. Very little K is removed from fields with the harvested alfalfa seed.

Potassium movement in soils is limited, although not to the same degree as P. As with P, K fertilizer recommendations are also based on calibrated relationships between soil test concentrations at the 0 to 12-inch depth and yield response (Table 2). Soil test K should generally be in the range of 120 to 160 parts per million (ppm) for optimum alfalfa seed yield.

Table 2. Recommended K fertilization rates for irrigated alfalfa seed based on soil test K concentrations.

Soil test K*	K application rate
(0-12 inches) (ppm)	(lb K_2O/acre)
0	180
40	120
80	60
120	0

*Sodium bicarbonate extraction

Potassium fertilizer should be incorporated during seedbed preparation before 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 seed. Potassium applications exceeding 300 pounds K_2O per acre should be split between fall and spring to avoid salt damage.

Sulfur

Sulfur (S) requirements for alfalfa seed vary with soil texture, leaching losses, soil test SO_4-S concentrations, and S content of the irrigation water. About 20 to 30 pounds of SO_4-S should be applied preplant to soils containing less than 8 ppm SO_4-S at the 0 to 12-inch depth. This amount should provide adequate soil S for 2 or 3 years of contracted alfalfa seed production, provided the SO_4-S is not leached from the rooting depth with excessive irrigation.

The SO_4-S form is mobile and can be leached to lower soil profile depths. For established alfalfa, sampling to a 2-foot depth will provide a more accurate indication of S availability to alfalfa roots.

Areas irrigated with water from the Snake River or other rivers fed by return flow should have adequate S for alfalfa seed production. Irrigation with well waters that are low in sulfur can lead to low soil S if S is not added periodically, particularly on course-textured soils with low organic matter content. Well waters with S concentrations of 2 ppm will provide about 5.4 pounds S per acre foot of water applied.

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 amounts of S to alfalfa in the application year.

Elemental S fertilizers, however, can supply considerable S during the year after application. Sulfate-sulfur sources, such as gypsum (calcium sulfate) ammonium sulfate (21-0-0-24), or potassium sulfate (0-0-52-18), provide readily available S and are recommended to correct S deficiencies during the year of application.

Secondary and Micronutrients

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

Micronutrient applications should be based on recent soil test results (Table 3). Boron (B) deficiencies can be corrected usually by applying 2 to 3 pounds B per acre once in the rotation. However, on very sandy soils, annual applications of 1/2 to 1 pound B per acre may be more effective. Commonly used forms of B include boric acid, borax, and sodium borate.

Zinc (Zn), manganese (Mn), copper (Cu), and iron (Fe) deficiencies can be corrected by applying 5 to 10

Table 3. Adequate soil test micronutrient concentrations for irrigated alfalfa seed.

Nutrient*	Adequate concentration
	(ppm)
Boron	>0.5
Zinc	>1.0
Manganese	>1.0
Copper	>0.2

*Boron determined from hot water extraction. Others determined from DTPA extraction.

pounds per acre of the required nutrient using soluble forms of Zn, Mn, Cu, or Fe. Molybdenum (Mo) availability is generally adequate in the alkaline soils that are prevalent in irrigated southern Idaho.

Tissue Testing

Plant tissue testing provides an effective means of evaluating the nutrient status of an established forage alfalfa stand, particularly where soil testing results are poorly correlated with yield as with boron. Samples should be collected from about 20 to 30 plants at early bloom in representative areas of the field. The top 6 inches of the stem should be sampled and sent to a testing lab for analysis.

Sufficiency levels for the various nutrients are presented in Table 4. Nutrient concentrations below these ranges suggest a need for supplemental fertilization. Concentrations of K above 4 percent may indicate excessive available K. The Table 4 sufficiency values were established for forage production so caution should be used when interpreting them for alfalfa seed production.

Table 4. Sufficiency ranges for nutrients in the top 6 inches of forage alfalfa stem tissue sampled at early bloom.

Nutrient	Sufficiency range
	(%)
Nitrogen	3.0 to 5.0
Phosphorus	0.25 to 0.75
Potassium	2.50 to 3.80
Calcium	0.50 to 3.00
Magnesium	0.30 to 1.00
Sulfur	0.25 to 0.50
	(ppm)
Boron	20 to 80
Zinc	20 to 70
Manganese	30 to 100
Copper	5 to 25
Iron	30 to 150
Molybdenum	1 to 5

When nutrient deficiencies are identified during the growing season, the deficiencies often can 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 seed is furrow irrigated, foliar sprays can be used to correct micronutrient deficiencies, but foliar applications of N, P, K, and S at high rates can cause leaf burning.

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For Further Reading

You may order this or other publications about fertilizers and crops in southern Idaho from University of Idaho 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 Web site: *http//info.ag.uidaho.edu*

CIS 838 *Inoculation of Legumes in Idaho* (35 cents)

PNW 570 *Monitoring Soil Nutrients Using a Management Unit Approach*

CIS 1102 *Southern Idaho Fertilizer Guide: Irrigated Alfalfa* (50 cents)

CIS 392 *Southern Idaho Fertilizer Guide: Irrigated Pastures, Southern Idaho* (25 cents)

CIS 828 *Southern Idaho Fertilizer Guide: Irrigated Spring Wheat* ($2.00)

CIS 1082 *Southern Idaho Fertilizer Guide: Irrigated Winter Barley* ($1.50)

CIS 373 *Southern Idaho Fertilizer Guide: Irrigated Winter Wheat* ($2.00)

CIS 1081 *Southern Idaho Fertilizer Guide: Onions* ($1.50)

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