AG-FO-0579
Revised 1987

FERTILIZER FOR ALFALFA

W.E. Fenster, Extension Soils Specialist
G.W. Rehm, Extension Soils Specialist

Minnesota Extension Service
University of Minnesota

Alfalfa fertilizer program

- Test soil to determine nutrient needs.
- Apply fertilizer to meet nutrient needs before seeding.
- Test plant tissue just prior to cutting to determine adequacy of fertilizer program.

Alfalfa—a high yield forage crop

Depending on climatic conditions, well managed alfalfa grown in Minnesota will produce 3 to 8 tons per acre; the state average is below 3 tons. Alfalfa can be produced on many different types of soil if the subsoil permits root penetration and essential nutrients and/or lime are not limiting. Alfalfa production can be low on wet, acid soils.

Alfalfa—a big feeder

In contrast to crops harvested for grain, alfalfa removes considerably more plant nutrients because the whole plant is harvested more than once during the growing season.

Field experiments have shown that alfalfa in Minnesota responds profitably to several nutrients. Different soils and even different soil conditions have produced wide variation in fertilizer needs. Some soil areas may need only one nutrient in a fertilizer program while others will show responses to potassium (K) phosphorus (P), sulfur (S), lime, and boron (B). The specific nutrient needs for any area or any field in an area must be determined by soil testing.

Alfalfa needs little fertilizer nitrogen

Alfalfa tissue has a high percentage of nitrogen (N). Bacteria in root nodules can manufacture usable N from the atmosphere. When alfalfa responds to applications of N fertilizer, the plants probably have not been inoculated effectively or the soil may be very sandy and acid.

Alfalfa requires only a small amount of N during its early stages of development. Fertilizer N encourages grass and weed growth. Therefore, use of fertilizer N for establishment of alfalfa is *not suggested* unless soils are very sandy with a low organic matter content.

Phosphate requirements

Investigators have found that each ton of harvested alfalfa hay will remove 10 to 15 pounds of P_2O_5 per acre from the soil. Phosphate requirements for alfalfa production in Minnesota are based on yield goal and soil test level for P. Table 1 shows the amount of phosphate fertilizer to apply at various soil test levels.

For best results, phosphate fertilizer, when needed, should be broadcast and incorporated to a depth of 3 to 4 inches before seeding.

Broadcasting phosphate fertilizer on the surface just after planting is the least desirable application method at seeding time. Since incorporation is still possible when fertilizer is applied prior to seeding, this practice should be used to place the fertilizer phosphorus where adequate moisture is more apt to be.

Annual topdressing with phosphate fertilizer to established stands is usually necessary for sustained production of high yielding alfalfa. Annual applications will insure that alfalfa yields are not limited by lack of phosphorus and may be necessary even if a seeding time application has been used. Phosphate fertilizer should be applied to established stands either in the fall or early spring just prior to the initiation of new growth.

Table 1. Phosphorus recommendations

	Phosphorus (P) Soil Test (lb/acre)[1]					
Yield goal	0-10	11-20	21-30	31-40	41-50	50 +
ton/acre	..... P_2O_5 to apply (lb/acre)					
7+	150	125	100	75	50	0
7	130	110	85	60	30*	0
6	115	95	70	45	20*	0
5	100	80	55	30*	0	0
4	85	65	40	20*	0	0
3 or less	70	50	30*	0	0	0

[1] Some labs report P and K soil test values in ppm. (ppm x 2 = lb/acre.)

* It may not be practical to broadcast these low rates each year. An alternative would be to double this suggested rate and broadcast on alternative years.

Phosphorus deficiency symptoms in alfalfa are very difficult to detect. A shortage of P usually reduces the size of the alfalfa plant while the leaves are often quite small and deep green.

Potash requirements

Compared to phosphorus, alfalfa requires large quantities of potassium (K) for growth and development. One ton of harvested alfalfa hay may remove 37 to 50 pounds of K from the soil. Alfalfa obtains the needed K from both soil and fertilizer sources. Potash fertilizer recommendations are based on both yield goal and soil test level for K. Take soil samples before seeding to determine the relative level of K in the soil. Table 2 indicates the quantity of K fertilizer to apply when different levels of K are present.

Broadcast and incorporate the needed potash before seeding. It should be mixed into the soil or plowed under.

On established stands of alfalfa, broadcast the potash fertilizer in the fall or early spring. Alfalfa will crown-feed, so surface application can be effective except when the surface soil is very dry.

A K deficient alfalfa plant is characterized by white specks on the leaf margin. Later, these specks join each other, causing a general yellowing and breakdown on the alfalfa leaf (figure 1).

Figure 1. Typical white speckles of potassium deficiency on alfalfa leaves. Lower leaves are affected first.

Table 2. Potassium recommendations

Yield goal	Potassium (K) Soil Test (lb/acre)[1] 0-75 Texture[2] F-M	C	76-150 F-M	C	151-225 F-M	C	226-300 F-M	C	301-350 F-M	C	350+ C
ton/acre	K_2O to apply (lb/acre)										
7+	300	350	250	300	200	250	150	200	100	150	0
7	260	300	210	250	160	200	110	150	60	100	0
6	220	250	170	200	120	150	70	100	30*	50*	0
5	180	200	130	150	80	100	30*	50*	0	0	0
4	140	150	90	100	40*	50*	30*	50*	0	0	0
3 or less	100	100	40*	50*	40*	50*	0	0	0	0	0

[1] Some labs report P and K soil test values in ppm. (ppm x 2 = lb/acre.)
[2] F-M = Loam, silt loam, silty clay loam, silty clay and clay textures.
C = Sand, loamy sand, and sandy loam textures.
* It may not be practical to broadcast these low rates each year. An alternative would be to double this suggested rate and broadcast on alternate years.

Lime needs

Alfalfa thrives in soils that contain ample amounts of calcium (Ca) and magnesium (Mg). Minnesota soils generally contain sufficient quantities of these nutrients to supply the needs of the alfalfa plant. There are, however, numerous soils in Minnesota that need lime to combat the acidity that reduces the activity of the nitrogen fixing bacteria. Additions of lime are required for good alfalfa growth on approximately a third of the cropland of Minnesota. Some acid sands may be low in Mg but if limed with dolomitic limestone the problem is solved.

Testing the soil for lime needs is a good management tool to use before seeding alfalfa. Use of recommended rates of lime insures a good alfalfa stand.

Eastern Minnesota soils generally are acid in the subsoil as well as in the surface plow layer and lime recommendations are higher than in western Minnesota, where subsoils are high in lime. Recommendations can vary from none to over 10 tons of limestone per acre.

If lime is needed, apply the material 6 to 8 months before the alfalfa is seeded. Lime must be incorporated into the tillage zone, that is about 6 inches deep. It is desirable that the lime be mixed as uniformly as possible in this soil area for the maximum benefit of the nodule bacteria. Disking prior to spreading to scatter and mix crop residues, for example, is desirable. When the lime is spread, disking again or chiseling may be necessary before plowing. The goal is to lime the upper 6 inches uniformly rather than the top 2 or 3 inches. This is especially important on moderately acid to strongly acid soils (pH 5.5 or lower). Plowing without first disking the lime into the soil usually results in a layer of lime at the base of the plow furrow. Applying lime as a topdressing to established stands of alfalfa seldom gives satisfactory results and is not recommended.

Using sulfur and boron

Research in Minnesota has shown that sulfur (S) is important in the nutrition of alfalfa on many soils in the north-central part of the state (figure 2). The soils most likely to be low in S supplying power are shown on the shaded area of the accompanying map. All soils in the shaded area are not S deficient, nor do all the soils in the non-shaded area have an adequate supply of S. There is a soil test for S; however, it is good only for predicting S needs on sandy soils. Table 3 shows S recommendations for sandy soils, based on soil test interpretations. Soil organic matter supplies a major part of the S used by alfalfa. So, S fertilizers are not needed for this crop on fine-textured soils with a medium or high organic matter content.

Table 3. Sulfur soil test interpretation and recommendations for soils with low or medium organic matter and coarse texture (sands, loamy sands, and sandy loams)

Sulfur soil test (ppm)*	Relative level	Yield increase expected from sulfur applications	S to apply each year
			lb/acre
0-6	Low	Highly possible	25-30
7-12	Medium	Possible	20-25
More than 12	High	Unlikely	0

*Sulfur soil test interpretation and recommendations for sandy soils.

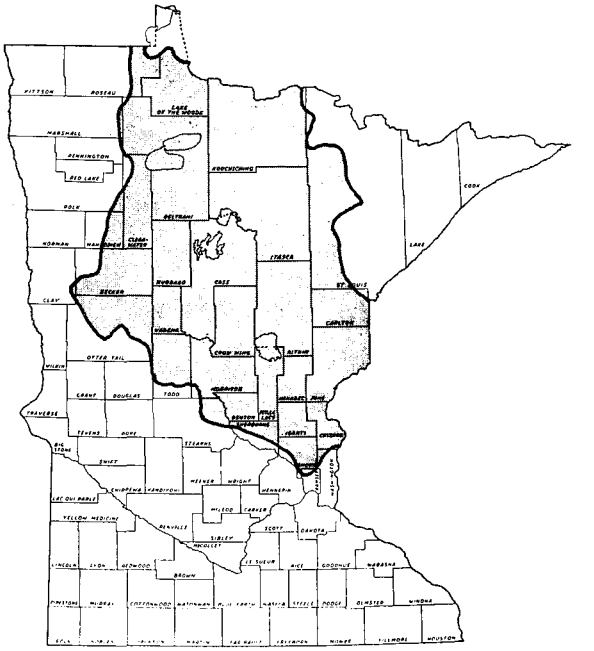

Figure 2. Shaded zone shows approximate area of highest probable sulfur deficient soils.

Sulfur deficiency in alfalfa can be recognized by light green in the entire leaf area (figure 3). There are several fertilizers that can be used to supply S when needed.

Sulfur products on the market vary with the area of the state. Blending of sulfur granules with PK or NPK combinations is a convenient method of application. This product contains nearly 90 percent sulfur, but must be converted to sulfate before absorption is possible. Sul-Po-Mag and K-Mag are brand name products containing 18 percent S, and are usually blended with other fertilizers; ammonium sulfate has 24 percent S but is less suited to alfalfa since the N is not needed. Gypsum contains 18 percent S for direct spreading but marketing in the state is very limited.

Responses of alfalfa to boron (B) applications have been demonstrated on the sandy and medium-textured soils in northeastern and east-central Minnesota. Symptoms of deficiency are most prevalent during dry periods because most of the available B is in the organic matter of the topsoil. When this layer becomes dry, breakdown of soil organic matter stops and no B is released for plant use.

Figure 3. Sulfur deficient alfalfa on the left, is demonstrated by reduced growth and light green leaves.

The total B content of the soil can be estimated by soil test. Table 4 lists current recommendations for B. Chemical analysis of the alfalfa plant is an excellent method for diagnosing B deficiency. When the level of B in young plant tissue is below 30 parts per million (ppm), a response to an application of B is likely. When tissue analysis or visual symptoms indicate a deficiency, apply 2 to 4 pounds of actual B per acre. Boron deficiency is associated with yellowing at the top of the plant and dying buds (figure 4). The branches of the alfalfa plant may continue to grow, giving the plant an umbrella-like appearance. For detailed information about B fertilizers see Minnesota Extension Service, AG-FO-0723, *Boron for Minnesota.* Both S and B are mobile in sandy soils and can be leached from the root zone with excessive moisture. These nutrients, when needed, should be applied each year. Apply recommended rates of both nutrients, when needed, for establishment.

Figure 4. Boron deficiency. The arrows show area of the dead growing point. Renewal of B supply will result in side branch growth.

Table 4. Relative boron levels in soil and suggested application rates

Boron soil test	Relative level	Alfalfa
ppm		lb B to apply/acre
0 -.9	low	2-4
1.0-5.0	adequate	0
more than 5.0	excessive	0

Alfalfa tissue composition

Investigators have shown that deficiency symptoms for the various plant nutrients appear when a nutrient drops to a certain concentration in the plant. Normal plant growth has been restricted long before this happens. Alfalfa producers shooting for high yields need to know whether plants are obtaining sufficient plant nutrients before the level in the plant restricts growth. Since the chemical composition of alfalfa varies according to plant age and the supply of nutrients available for growth, plant tissue testing can help detect mild deficiencies before acute and visual symptoms appear. Tables 5 and 6 show the plant nutrient levels established for various nutrients covering the range from deficient to excess.

Table 5. Levels of major nutrients in the alfalfa plant before bloom, top part of plants*

	Level in alfalfa				
Nutrient	Deficient	Low	Sufficient	High	Excess
			% in tissue		
Phosphorus	<.20	.20-.25	.26-.70	.71-1.00	1.00+
Potassium	<1.75	1.75-2.00	2.01-3.50	3.51-5.00	5.00+
Calcium	<1.00	1.00-1.75	1.76-3.00	3.01-4.00	4.00+
Magnesium	<.20	.20-.30	.31-1.00	1.01-2.00	2.00+
Sulfur	<.20	.20-.29	.30	—	—

* Based on Ohio data.

Table 6. Micronutrient levels in alfalfa plant before bloom, top part of plant*

	Level in alfalfa				
Micro-nutrient	Deficient	Low	Sufficient	High	Excess
			ppm in tissue		
Manganese	<20	20-30	31-100	101-250	250+
Iron	<20	20-30	31-250	251-400	400+
Boron	<20	20-30	31-80	81-100	100+
Copper	<5	5-10	11-30	31-50	50+
Molybdenum	<.5	.5-.9	1.0-5.0	5.1-10	10+
Zinc	<10	10-20	21-70	70-100	100+
Aluminum	—	—	<200	201-400	400+

* Based on Ohio data.

When sampling alfalfa for tissue analysis, take the top 6 inches of 20 plants at early bud stage. Consult the county extension agent or a laboratory that provides plant analysis service before taking tissue samples to check on procedure. Plant samples should be dried in an oven at 140° to 175° F for 48 hours, or air dried in a well-ventilated room for one week.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Patrick J. Borich, Dean and Director of Minnesota Extension Service, University of Minnesota, St. Paul, Minnesota 55108. The University of Minnesota, including the Minnesota Extension Service, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, religion, color, sex, national origin, handicap, age, veteran status, or sexual orientation.