MINNESOTA EXTENSION SERVICE
UNIVERSITY OF MINNESOTA
AGRICULTURE

Fertilizing Alfalfa in Minnesota

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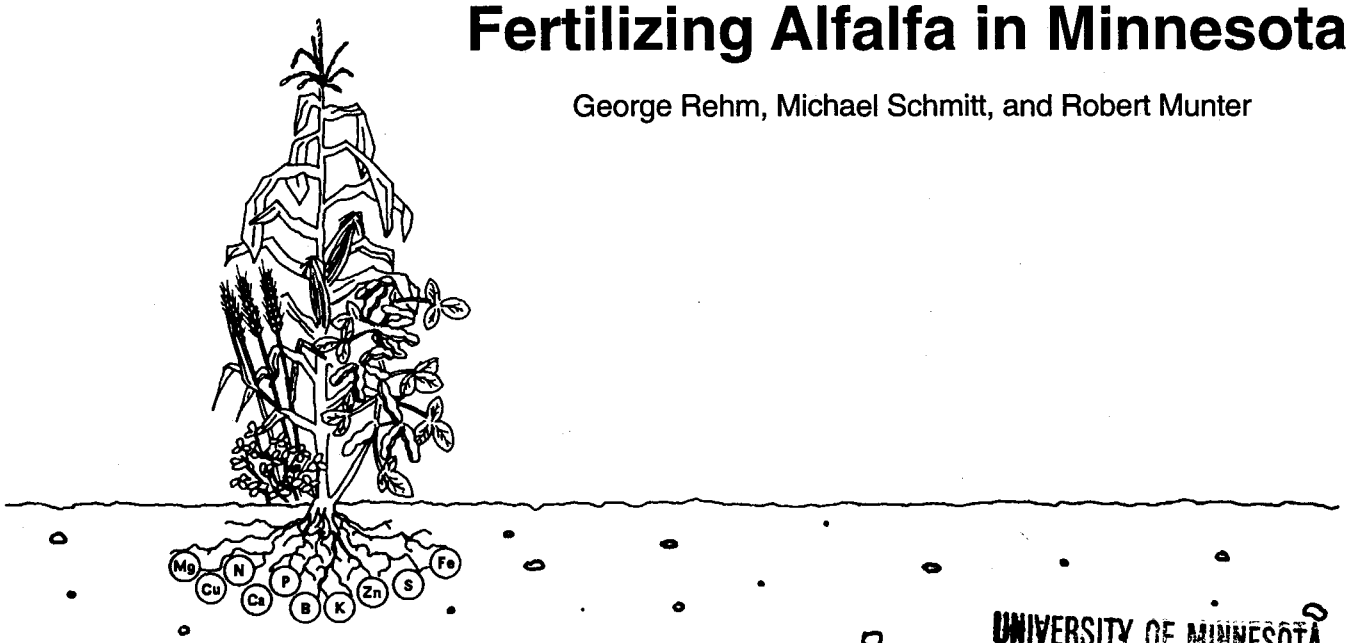

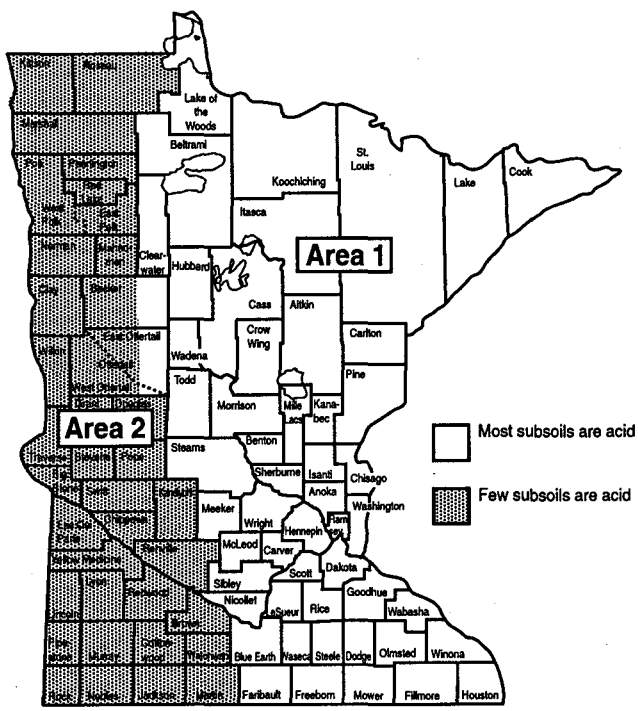

Figure 1. Reference map for lime recommendations.

Alfalfa is grown on approximately 2 million acres in Minnesota. It is a key component of farm enterprises that include dairy and/or beef animals. Alfalfa is also frequently grown as a cash crop being sold to a variety of users. A well managed fertilizer program is a key ingredient in the efficient and profitable production of this crop.

When alfalfa production is considered, major emphasis should be devoted to 1) the proper use of lime and 2) application of appropriate rates of phosphate, potash, sulfur, and boron.

pH and Liming

Profitable alfalfa production starts with a consideration of soil pH and lime needs. A pH of 6.5 or higher is desired for optimum alfalfa yields. When lime is used to raise the soil pH to this level and above, alfalfa growth is improved because there is a more favorable environment for the growth and development of rhizobia bacteria. These bacteria allow the alfalfa crop to manufacture the nitrogen (N) that it needs from the nitrogen in the atmosphere.

The availability of phosphorus (P) is also affected by soil pH. Liming to a pH of 6.5 increases the availability of both soil and fertilizer P to plants. Soils in Minnesota contain ample calcium (Ca) for crop growth. Liming materials are not used to supply Ca.

Determining the Need for Lime—The need for lime is not uniform across Minnesota and recommendations will vary. Analyzing a soil sample for pH and buffer pH is the only way to arrive at an accurate lime recommendation. Soils should be sampled to 6 inches. The recommendations will not be accurate if other sampling depths are used.

Lime recommendations for alfalfa production are summarized in Tables 1 and 2. The location of the field within the state must also be considered when the recommendations in **Tables 1** and **2** are used (see **Figure 1**).

In Minnesota, lime recommendations are given in terms of pounds of ENP (Effective Neutralizing Power) per acre. Liming materials are analyzed and the results are reported as pounds of ENP per ton. With this information, it's easy to calculate the tons per acre of a liming material needed to raise the soil pH to 6.5. A more detailed discussion of ENP and the variety of liming materials available is provided in Extension Fact Sheet AG-FS-5957.

The approximate recommendations for the use of ag lime (crushed limestone) are also listed in **Tables 1** and **2**. These suggestions can be used when soil testing laboratories report lime recommendations in terms of tons per acre instead of lb. ENP per acre.

Phosphate Use

When needed, phosphate fertilizers can produce substantial increases in alfalfa yield. Phosphate fertilizer recommendations are based on a yield goal and the results of the analysis of a soil sample for phosphorus (P). These suggestions are summarized in **Table 3**.

Potash Suggestions

Potassium (K) may be the most limiting nutrient for alfalfa production in central, east-central, and southeastern Minnesota. Potash fertilizer recommendations should be based on a realistic yield goal and the results of the analysis of a soil sample for K. The potash suggestions for alfalfa production in Minnesota are summarized in **Table 4**.

Table 1. Lime recommendations for mineral soils when the soil pH is less than 6.0. The rates suggested should raise the pH to 6.5.

SMP Buffer Index	Area I		Area II	
	ENP	Ag Lime*	ENP	Ag Lime*
	lb./acre	*ton/acre*	*lb./acre*	*ton/acre*
6.8	3000	3.0	2000	2.0
6.7	3500	3.5	2000	2.0
6.6	4000	4.0	2000	2.0
6.5	4500	4.5	2000	2.0
6.4	5000	5.0	2500	2.5
6.3	5500	5.5	2500	2.5
6.2	6000	6.0	3000	3.0
6.1	6500	6.5	3000	3.0
6.0	7000	7.0	3500	3.5
5.9	7500	7.5	3500	3.5
5.8	8000	8.0	4000	4.0
5.7	8500	8.5	4000	4.0
5.6	9000	9.0	4500	4.5

** These are approximate recommendations based on the average ENP value of ag lime. An ENP of 1,000 lb. per ton is an average value for ag lime (crushed limestone) in Minnesota.*

Table 2. Lime recommendations for mineral soils when the SMP BUFFER TEST IS NOT USED (soil pH is 6.0 or higher). The rates suggested should raise the pH to 6.5.

Soil-Water pH	Area I		Area II	
	ENP	Ag Lime*	ENP	Ag Lime*
	lb./acre	*ton/acre*	*lb./acre*	*ton/acre*
6.5	0	0	0	0
6.4	2000	2.0	0	0
6.3	2000	2.0	0	0
6.2	3000	3.0	0	0
6.1	3000	3.0	0	0
6.0	3000	3.0	2000	2.0

** These are approximate recommendations based on the average ENP value of ag lime. An ENP of 1,000 lb. per ton is an average value for ag lime (crushed limestone) in Minnesota.*

Table 3. Phosphate suggestions for alfalfa production in Minnesota.*

Yield Goal	Phosphorus (P) Soil Test (ppm)				
	Bray:	0-5	6-10	11-15	16-20	21+
	Olsen:	0-3	4-7	8-11	12-15	16+
bu./acre	*lb. P_2O_5/acre to apply*				
3 or less		40	35	20	5	0
4		65	45	25	10	0
5		80	55	30	15	0
6		95	65	40	15	0
7		110	80	45	20	0
more than		125	90	55	25	0

** Use the following equations to calculate phosphate fertilizer recommendations for specific yield goals and specific soil test values for P:*

P_2O_{5Rec} = [18.57 - (.93) (Bray P Test, ppm)] (Yield Goal)

P_2O_{5Rec} = [18.57 - (1.16) (Olsen P Test, ppm)] (Yield Goal)

No phosphate fertilizer is recommended if the soil test for P is higher than 25 ppm (Bray) or 20 ppm (Olsen).

Phosphate and Potash Management

Annual applications of fertilizer, based on the results of a soil test, are suggested for the production of high-yielding alfalfa. In the year of establishment, the suggested rates of phosphate and/or potash should be broadcast and incorporated before seeding. These suggested rates should be adequate for the seeding year. For the first full year of production, repeat the application that was used for the seeding year.

Soil samples should be collected again in the fall of the first full year of production. The amounts of phosphate and/or potash needed for the second and third production years can be based on the results of this test.

Needed fertilizer can be applied in either spring or fall if soils are not sandy. Spring applications are suggested when soils are sandy. Sulfur (S) may be needed when soils are sandy, is mobile, and should not be applied in the fall. A soil test for S is suggested if soils are sandy. Split applications can be used for alfalfa and are considered to be a good management practice. This is especially true if high rates of phosphate and/or potash fertilizer are needed. If split applications are used, the fertilizer should be applied in early spring and repeated after the 1st cutting.

Some of the rates for phosphate and potash use listed in **Tables 3** and **4** are small. Most fertilizer spreaders cannot be adjusted to apply these low rates. In some situations, the recommended rate of phosphate can be blended with the recommended rate of potash and the mixture can then be spread with available equipment.

In other situations, broadcast applications of low rates of only phosphate or potash may be suggested. For these fields, it may be more practical to double the suggested broadcast rate and apply on alternate years.

Nitrogen Use

The use of nitrogen (N) fertilizer is not recommended when alfalfa is seeded in medium or fine-textured soils. In these situations, application of a N fertilizer may reduce nodulation. Small amounts of a N fertilizer may enhance establishment when alfalfa is seeded in a coarse-textured soil. The N rate should be held to 25 lb./acre or less.

A small amount of N may be applied when alfalfa is seeded with a nurse or companion crop. This is especially true when soils are sandy. The suggested N rate for this planting situation is 30 lb./acre.

Table 4. Potash suggestions for alfalfa production in Minnesota.*

Yield Goal	Potassium (K) Soil Test (ppm)				
	0-40	41-80	81-120	121-160	161+
bu./acre	*K_2O to Apply* (lb./acre)*				
3 or less	145	100	55	10	0
4	190	130	70	10	0
5	240	165	90	15	0
6	290	195	105	15	0
7	335	230	125	20	0
more than 7	380	265	145	20	0

**Use the following equation to calculate potash fertilizer recommendations for specific yield goals and specific soil test values for K:*

K_2O_{Rec} = [55.7 - (.38) (Soil Test K, ppm)] (Yield Goal)

Table 5. Sulfur suggestions for alfalfa production on sandy soils in Minnesota.

Soil Test for S	Sulfur Suggestions
ppm S	*sulfur to apply (lb./acre)*
0-6	25 (annual)
7-12	25 (trial)
more than 12	0

Table 6. Boron recommendations for alfalfa production in Minnesota.

Boron Soil Test	Relative Level	Boron To Apply
ppm		*lb./acre*
less than 1.0	low	2-4
1.1 - 5.0	adequate	0
more than 5.0		0

There is usually no benefit from topdressing fertilizer N to established stands unless there is firm evidence that nodulation is not present. Many times, weeds and grasses appear as the alfalfa stand ages. The application of fertilizer N or manure will stimulate the growth of both. This could accelerate the disappearance of alfalfa from the stand.

Sulfur Needs

Several research trials have clearly demonstrated that the use of sulfur (S) in a fertilizer program will increase the production of alfalfa grown on sandy soils. **Table 5** lists sulfur suggestions based on the results of a soil test for S.

In Minnesota, the soil test for S is only reliable for sandy soils. This soil test has no value for medium and fine textured soils.

Sulfur is mobile in soils—especially sandy soils. When needed, this essential nutrient should be applied each year in early spring. The annual applications of S fit easily with annual applications of phosphate and/or potash.

Micronutrient Needs

In Minnesota, boron (B) is the only micronutrient that might be needed in a fertilizer program for alfalfa. Soils in Minnesota contain adequate amounts of copper (Cu), manganese (Mn), iron (Fe), and zinc (Zn) for optimum alfalfa production.

Soils that have either marginal or deficient levels of B are limited to the state's east-central and northeastern regions. A soil test for B is available, but this test is recommended for use only in the two areas just mentioned. The suggestions for use of B fertilizer are listed in **Table 6.**

When needed, B fertilizers can be topdressed to established stands. Because of the low rates of B needed, this nutrient should be broadcast with phosphate and/or potash fertilizers for best results.

Boron is also mobile in soils and should be applied each year. This nutrient should not be applied directly to actively growing green tissue because some serious plant injury could occur. Boron fertilizers should never be applied to germinating seed.

Additional Publications

Check your local county extension office for these publications:

AG-FO-0792—*Phosphorus for Minnesota Soils*

AG-FO-0794—*Sulfur for Minnesota Soils*

AG-FS-5957A—*Liming Materials for Minnesota Soils*

AG-FO-5956B—*Lime Needs in Minnesota*

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