Fertility of Alfalfa

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Alfalfa production requires large amounts of nutrients from the soil reservoir or a well-planned fertilization program. To plan a fertilization program, a complete soil test should be performed prior to seeding to inventory soil nutrients and to identify potential production problems.

If the soil test indicates <6.0 pH, serious consideration should be given to liming. Uncorrected, acid soils will limit productivity and little can be done to correct acidity once the crop is planted. If the soil test indicates medium or low levels of phosphorus (P) and/or potassium (K), these immobile nutrients should be preplant incorporated to meet alfalfa requirements for at least the first and second production years.

Table 1. *Nutrients removed by a ton of alfalfa.*

Nutrient	Symbol	lb/ton removed
Nitrogen	N	64.00
Potassium	K	50.00
Phosphorus	P	6.00
Calcium	Ca	30.00
Sulfur	S	6.00
Copper	Cu	0.33
Boron	B	0.08
Zinc	Zn	0.05

Alfalfa hay removes large amounts of nutrients from the field, especially nitrogen (N), K, and calcium (Ca) (Table 1). Fortunately, a nodulated alfalfa plant fixes N in a symbiotic relationship with rhizobium eliminating the need for N fertilization. Nitrogen fertilization has rarely given a yield increase, but it does not adversely affect the plant either.

Alfalfa is an extremely heavy feeder on K (Table 1). Typically, alfalfa has 2.2-3.0% K in the forage unless soils are very deficient. Most soils in the Dakotas and NW Minnesota are high to very high in K so little K fertilization is needed. Soils in SE Minnesota and southern Wisconsin are low in K so extensive K fertilization is needed. Potash fertilizer recommendation for various yield goals and soil test levels is found in Table 2. Generally, K needs can be met with one fertilizer application per year unless the soil test is low or very low, then split applications might be warranted. High K in hay is a problem in some feeding situations making it a disadvantage of high K-testing soils or extensive fertilization of medium-testing soils.

Phosphorus is the most frequently deficient nutrient for alfalfa production in areas with high K-testing soils even though removal rate is about 10% of that of K (Table 1). Recommended phosphate fertilization level by yield goal and soil test is presented in Table 3. Triple phosphate (0-44-0) can be used, but ammonium phosphate is commonly used due to availability. If using ammonium phosphate, be sure to price the fertilizer based on cost/unit of P and give no credit for the N since N fertilization is unnecessary.

Most P and K fertilizers are broadcast on the surface in established stands. Fertilizer-use efficiency is better if the fertilizer is knifedinto the soil ~3". Increased forage yield will occur with knifed in fertilizer under high yield conditions, but broadcast on the surface is far superior to no fertilization on low-testing soils.

A ton of hay removes a similar amount of sulfur (S) as P (Table 1), but there is much less need for S fertilization than P. Sulfur deficiency is most common on sandy soils with low organic matter. Sulfur fertilization is a common practice on irrigated sandy soils, but recent data indicates that S deficiency can occur on loam soils with nearly 3% organic matter. Free sources of sulfur, acid rain and sulfur in phosphate fertilizers, have been basically lost and S deficiency is becoming a more common problem. Unfortunately, S soil tests are not nearly as reliable as P and K. If spots in the field (generally hillsides) are spindly, light green, and low in stem density, try a S test strip.

Micronutrient fertilization may be important on some soils. Many soils in central North Dakota have been testing ~0.5 ppm boron (B) in the top 6" of soil, a potentially deficient level. Boron is important in nitrogen fixation and fertilization may be needed. However, one experiment on soil testing 0.4 ppm B did not show a yield response to B fertilization at 2 lb/ac, possibly indicating that adequate B was deeper in the soil. Remember, B is a true micronutrient that can become toxic if over applied. Zinc (Zn) levels have tested <1 ppm, some <0.4 ppm, in many soils in North Dakota, western Minnesota, and northern South Dakota; yet, several strip applications of zinc sulfate have failed to document a yield response.

Other micronutrients may also be important in alfalfa hay production. Max-In (proprietary foliar micronutrient mix by Agriliance) was found to increase relative feed value of alfalfa hay in 11 of 18 comparisons in Minnesota, 9 of 12 in Wisconsin, and 6 of 6 in South Dakota. Average increase was 21, 28, and 11 units in Minnesota, Wisconsin, and South Dakota, respectively. Some locations have reported yield increases also.

For top yielding alfalfa, the nutrient supply must be in balance. The most limiting nutrient supply will prevent further production. For example, Max-In was applied on a sulfur deficient site in west central Minnesota with no effect on yield. Max-In does not contain sulfur so it is not surprising to see no yield effect. Application of 20 lb S/ac as gypsum or zinc sulfate increased the forage yield of the first harvest from 0.9 tons/ac in the check and 50 P/100 K treatments to 2.0 tons/ac, a 122% increase. Next year, Max-In will be applied to a sulfur treatment to see if any other micronutrient is limiting.

Table 2. *Potassium fertilizer recommendations for alfalfa*

	Soil test potassium, ppm				
Yield goal	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
tons/ac	---------- lb K_2O/acre ----------				
2	105			10	0
4	195			25	0
5	245	75	45	30	0
6	295	140	80	35	0
		170	100		
		205	120		

Table 3. *Phosphorus fertilizer recommendations for alfalfa*

		Soil test phosphorus, ppm				
Yield goal	Bray-I Olsen	VL 0-3 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+
tons/ac		---------- lb P_2O_5/acre ----------				
2		195			10	0
4		245	75	45	15	0
5		295	140	80	15	0
6			170	100		
			205	120		