DETECTING NUTRITIONAL NEEDS OF ALFALFA

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Perhaps a good way to begin a discussion on nutritional needs of alfalfa is by gaining some appreciation for the total quantity of nutrients removed by eight tons of alfalfa hay (Table 1). A brief discussion of how these nutrients are obtained by alfalfa will lead to areas of consideration where nutrient additions may be required.

The mutually beneficial relationship between rhizobia bacteria and the alfalfa plant will usually provide an ample supply of nitrogen. Although this assumption is often made, conditions for maximizing the fixation of nitrogen are essential for the production of high yielding alfalfa. Vigorously growing plants, including the roots as well as the tops, are necessary to insure an adequate nitrogen supply. Since a large portion of the nodules are located in the 2 to 15 inch soil depth, consideration must be given to fertility, moisture status and physical conditions as they might influence root growth. Soil which is allowed to become dry to considerable depth will reduce the fixation capacity by placing the plant and rhizobia under moisture and other stresses. Continuous progress in strain selection makes it advisable to inoculate seed for new plantings to provide the most efficient rhizobia.

Potassium and calcium are also taken up in rather large quantities. With the possible exception of some sandy soils and perhaps a few others, the availability of potassium in most soils is adequate for maximum yield production. Potassium should not, however, be overlooked as it contributes to disease resistance in addition to the functional roles in plant growth. Nutrient supplies of calcium very seldom limit alfalfa yields unless soil pH levels drop somewhat below 5.0 - 5.5. Optimum soil pH for alfalfa is 6.0 or above so that acid soils usually respond to application of lime.

TABLE Amount of Nutrients Contained in 8 Tons of Alfalfa Hay.

Nutrient	Pounds
N	400
P_2O_5 (P)	94 (42)
K_2O (K)	350 (290)
Ca	256
Mg	53
S	32
Fe	3
Mn	2
Zn	0.2
Cu	0.2
Cl	2
Mo	0.01
B	.5

Although a smaller quantity of phosphorus is needed by alfalfa as compared to nitrogen, potassium and calcium, the availability of phosphorus frequently limits hay production. Studies conducted throughout the state have indicated that significant alfalfa yield responses have followed phosphorus fertilizer applications.

Table 1 lists a number of secondary- and micro-nutrients which are required for plant growth. Of these, sulfur and boron deserve a special note as additions have frequently given yield responses. This is particularly true in the higher rainfall areas of the northern part of the state.

When to Fertilize Alfalfa?

Unfortunately, after rather disappointingly low alfalfa yields have been harvested, it is often difficult to supply the necessary plant nutrients. This is certainly true in the case of phosphorus which is generally the nutrient most limiting for top yields. Good management requires that an abundant quantity be available to alfalfa for vigorous growth and hardy plants. This means incorporation of phosphorus fertilizers in the surface eight inches of soil BEFORE the alfalfa is established. Soil tests should be taken a month or so before planting as they provide the best guideline for applying the amounts of phosphorus needed. Incorporation of potassium, sulfur and boron is desirable before planting if a deficiency or response is suspected or known.

Fertilizing established stands of alfalfa poses a more difficult problem. Since phosphorus or potassium move very slowly in the soil, perhaps a half inch per year at best, fertilizers applied on the soil surface are not very efficient. Although some phosphorus and potassium are taken up by alfalfa from the surface inch or two of soil, this layer usually lacks moisture and dries out rather quickly after an irrigation, thus allowing little time for roots to absorb nutrients during periods of maximum growth. Sulfur and boron fertilizers are more soluble and will move down into the soil with irrigation or rainfall. If soil tests from older stands indicate a low nutrient level, it would be advisable to apply fertilizer. Remember, however, that this is a less efficient way to provide alfalfa with needed phosphorus and potassium supplies.

Soil test values greater than 20 ppm bicarbonate phosphorus, 100 ppm exchangeable K or 300 ppm hot nitric acid K, 20 ppm sulfate sulfur usually indicate adequate levels and responses are unlikely. Soils testing below 10 ppm (HCO_3-P), 50 ppm exchangeable K or 200 ppm hot nitric K, 10 ppm SO_4-S and 0.1 ppm boron will usually respond to fertilizer additions.

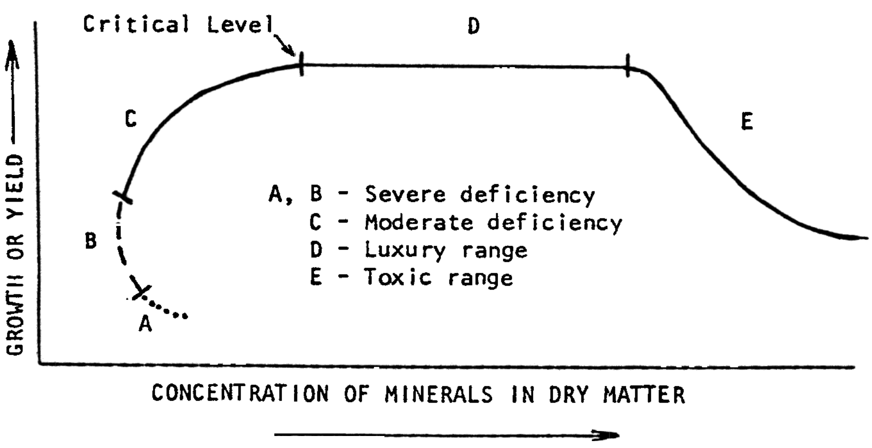
Checking the Nutritional Status During the Season

Another important tool available to growers for evaluating the nutritional status of alfalfa is the plant tissue analysis. Careful interpretation of the results along with a consideration of what soil tests indicate will provide direction to a sound fertility program. One important item should remain uppermost in the evaluation of any plant tissue analysis -- the single plant nutrient most deficient is responsible for reduced growth or a decrease in yield. That is to say, if phosphorus is the most deficient, alfalfa must be supplied phosphorus before the concentration of other nutrients should be considered. Likewise, if sulfur is most limiting, phosphorus and other nutrient concentrations should be checked after an adequate level of sulfur is achieved. Conversely, if a toxic or extremely high concentration of a nutrient is observed, consideration must be given as to how this might be reduced before other nutrient levels are evaluated.

Perhaps the figure below wil help illustrate the interpretation of plant analysis.

RELATION OF MINERAL COMPOSITION OF TISSUE TO GROWTH OR YIELD

AFTER SMITH (1962) AND PREVOT AND OLLAGMIER (1957)



The point indicated as the critical level is probably the most informative because it represents the concentration below which reductions in yield may be expected due to a limited supply of the nutrient. It is also the nutrient concentration at which nearly maximum yields are produced. An example of how this might happen in the field is where increasing rates of say phosphorus such as 0, 100, 200, 300, 400 and 500 pounds per acre are applied to a soil testing low in phosphorus. Let us say that the phosphorus concentration and alfalfa yield increased up to the 400 pound rate but the 500 pound rate gave no higher yield even though it had a greater phosphorus level in the plant tissue. The critical level would be the phosphorus concentration at which the highest yields were harvested. This is accomplished by taking parts of the above ground portions of plants, usually at 1/10 bloom, to analyze for phosphorus, potassium, sulfur, and perhaps molybdenum and boron content. Use of this technique enables the grower to evaluate whether adequate amounts of nutrients are being taken up by the plants. This also provides a means of determining how well applied fertilizers are utilized. Table 2 gives the plant tissue levels desired in the plant parts indicated.

TABLE 2. Nutrient Concentrations in Alfalfa at Different Response Levels.

Response category	Total K (middle	PO_4-P stems)	SO_4-S (leaves)	Total Mo (whole	Total B tops)
	%	ppm	ppm	ppm	ppm
Deficient	.40-.65	300-500	<80	<0.3	<15
Critical	.65-.80	500-800	80-150	.9	15-20
Adequate	.80-1.5	800-1500	150-500	-5	20-40
High	.5+	1500+	500-100	5-10*	200+

*Forage containing more than 10 ppm of Mo may produce "molybdenosis" in ruminant animals.

+Boron concentrations in alfalfa greater than 200 ppm are associated with reduced growth and vigor.

Deficiency symptoms in plants may be helpful in identifying fields which need a more adequate nutrient(s) supply. However, a word of caution might be that positive identification is often difficult for the experienced observer, particularly if an extremely low level of one nutrient has brought about other nutrient imbalances which have altered the usual symptoms.

Which Fertilizers for Alfalfa?

Most of the early fertilizer trials involved single super-phosphate (18 to 20 % P_2O_5) largely because of its being one of the first and, in some cases, the only source on the market. Treble super-phosphate (40 to 50 % P_2O_5), phosphoric acid and numerous combinations of nitrogen with phosphorus in both dry and liquid forms have since become available. Evaluations of these phosphorus-containing fertilizers have shown little, if any, differences in alfalfa yield responses. What must be considered, however, is that alfalfa usually derives its nitrogen from the symbiotic rhizobia bacteria, thus it seems rather inefficient to apply nitrogen to alfalfa except in the situation where a new seeding is made. It should also be pointed out that many times a sulfur response occurred when single super-phosphate (which contains 10 to 12 % sulfur) was applied and this was thought to be entirely a response to phosphorus. Whether or not the continued use of low sulfur containing phosphorus fertilizers will lead to more widespread deficiencies of sulfur in alfalfa remains to be seen. Gypsum or one of a number of elemental sulfur fertilizers may be used to supply sulfur. It is desirable to incorporate higher rates of elemental sulfur (100-400 lbs/acre) several months before planting so as to allow sufficient time for oxidation and accumulation of the sulfate form.

Using Manure on Alfalfa

Various types of manure can be applied on alfalfa to supply nutrients and provide other benefits. Nitrogen, phosphorus, potassium and some micronutrients are present in varying amounts and this should be considered when fertilizer applications are made. Analysis of the manure being applied would be a necessary step in evaluating the benifits as well as indicating possible problem areas. If large applications (approaching 15 to 20 tons per acre per year) are made, irrigation practices necessary to leach the additional salts should be observed. Other beneficial effects arise largely from the manure contribution to improvements in physical characteristics of the soil such as possible increased infiltration rate, aeration and water-holding capacity. Perhaps the greatest disadvantage in using manures would be the weed seeds spread throughout the fields.