HOW TO PREDICT FERTILIZER NEEDS OF ALFALFA

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Plant analysis, soil analysis, nutrient deficiency symptoms, and the use of field fertilizer experiments all are helpful in predicting the fertilizer needs of alfalfa. In addition, water analysis may be useful in identifying cause of poor growth. We must recognize that alfalfa as usually grown is a dual system composed of the alfalfa plant itself and the associated rhyzobial bacteria which inhabit the root nodule and fix most of the nitrogen used by the alfalfa plants.

In discussing the problems of alfalfa fertilization we will first point out the essential mineral nutrients taken up by alfalfa roots from the soil and indicate the relative importance of each of these in terms of the actual amounts removed in a 10 ton crop.

(TABLE 1)

NUTRIENT REMOVAL BY ALFALFA CROPPING

Nutrient	Hay Composition ppm in Hay	Removal in Hay lbs. Ac in 10 tons
Nitrogen	25000	500
Potassium	18000	360
Calcium	16000	320
Magnesium	3300	66
Phosphorus	2600	52
Sulfur	2400	48
Iron	200	4
Chlorine	150	3
Manganese	100	2
Boron	30	.6
Zinc	15	.3
Copper	10	.2
Molybdenum	1	.02

Table 1 indicates the average amount of each of the macro and micronutrient elements harvested annually by normal healthy alfalfa are shown in Table 1. These results are from several sources including the values reported by the National Research Council in their publication #585 entitled, "Composition of Cereal Grains and Forage". These values above illustrate the magnitude of nutrient removal by a healthy crop. Nutrients may be taken up in considerably larger amounts as luxury uptake from very rich soils, or in lessor amounts than the values indicated, if they happen to be deficient.

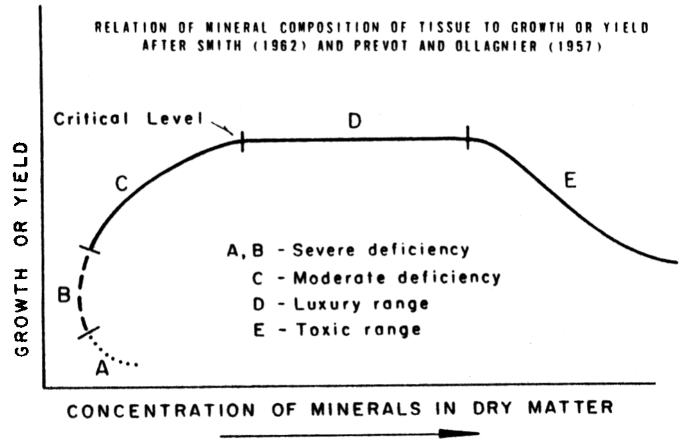
In California the nutrients most commonly in low supply that may be provided through intelligent fertilization are; potassium, phosphorus, sulfur, and boron. Occassionally, additions of nitrogen, molybdenum, or iron may be desirable. Calcium is rarely deficient but the addition of ground limestone, (a calcium carbonate) may be necessary in order to make alfalfa grow well on some acidic soils.

Deficiency Symptoms can be very helpful in identifying fields needing fertilization. Deficiencies of sulfur, potassium, and boron are illustrated in accompanying slides. Phosphorus deficiency though common has no real really characteristic symptoms other than small weak growth and narrow leaves. Occassionally, potassium and boron deficiency may occur in the same field. The symptoms however are usually quite distinct as shown in the accompanying slides.

Plant analysis is a very useful tool to determine the nutrient status of growing alfalfa plants. We must recognize however, that plant analysis is a result of growth and nutrient supply and that it reflects with certainty only the nutrient that actually limits growth. Thus, if P is low, values for S and K will not reflect potential supply of those latter nutrients. Similarly if potassium is low, phosphorus and sulfur values must be re-examined after the nutrient K deficiency has been corrected. Likewise, if sulfur is acutely deficient the values of P and K will have to be re-examined after the sulfur has been applied. Thus, plant analysis will help us pick out the limiting factor. We must then re-examine the revised status of other nutrients after the primary deficiency limiting growth has been corrected. Only rarely will we find more than one nutrient deficient initially. Sometimes both boron and potassium may be deficient.

Plant analysis gives us a chance to determine whether our fertilization program has been adequate and tells us which nutrients we should add in follow-up refertilization treatments.

The concept of critical values may be of use in explaining how plant analysis works. If we lay out a careful rate experiment in the field, say of phosphorus where it is the only limiting factor; we should come up with range of plants going from extreme deficiency to complete adequacy if sufficient phosphorus is added. The phosphorus content at which yields no longer increase as larger amounts of P fertilizer are applied is the critical level. Plant composition below this point represents deficiency. Composition above this point represents adequate or luxury uptake.



We commonly sample producing alfalfa fields in an effort to find out how hungry they are, and whether fertilizer treatments have been adequate. We should sample alfalfa at 1/10 bloom, since earlier or later samples give erroneous results. We prefer to take about 40 stems discarding the upper and lower one-fourth thus sampling only the middle one-half of the plant. This "middle-stem" sample we separate into leave and the stem fractions. The stem gives us a good nutrient evaluation for phosphorus and potassium. The leaves from the midstem give us a sensitive measure of sulfur nutrition. For boron, or molybdenum we usually use the entire top as a sample. Nutrient ranges showing the values for deficient, critical, adequate, and high are shown in the following tables.

(TABLE 2)

NUTRIENT RANGES FOR ALFALFA AT 1/10 BLOOM

	MIDSTEMS		LEAVES	WHOLE TOPS	
Range	K	P	Sulfur	Molybdenum	Boron
Deficient	.40-.65	300-500	80	.5	15
Critical	.65-.80	500-800	80-150	.5-.9	15-20
Adequate	.80-1.5	.8-1.5 800-1500	150-500	1-5	20-40
High	1.5+	1500+	500-1000	5-10	200*
Excess *				1000*	
Expressed as	% Total K	ppm PO_4-P	ppm SO_4-S	ppm Total Mo	ppm Total B

Soil Analysis may be helpful in determing what treatments should be made prior to planting of alfalfa. Because of the great depth of the alfalfa root system it is difficult to sample the soil explored by alfalfa roots. Soil analysis is more effective in determining what fertilizer to use prior to planting then to tell us what to apply to existing stands

Soil pH values are of considerable importance. Most California soils with pH values of 6.0 or higher are OK for alfalfa. If values are below pH 5.5 we often see poor growth with nodules fixing little or no N. Here N+$CaCO_3$ applications may help on mineral soils. Peats or mucks with pH between 5.0 - 6.0 often grow good alfalfa as peak breakdown supplies N. pH values of 5.0 and lower show very poor alfalfa growth with no nodules and stubby roots due to toxic amounts of aluminum. Here lime applications are a must if we wish to grow alfalfa.

Tentative soil analysis values for P, K and S are shown in Table 3

NUTRIENT	RESPONSE POSSIBLE	RESPONSE NOT LIKELY
P (HCO_3)	Below 10 ppm	Over 20 ppm
K (exchangeable)	Below 50 ppm	Over 100 ppm
SO_4-S	Below 10 ppm	Over 20 ppm
Zn	observed response very rare	

If soil values for P (HCO_3-P) are over 20 ppm, exchangeable K over 100 ppm and SO_4-S over 20 ppm it is very unlikely we will benefit from P, K or S fertilizers.

If values are in the "Response Possible" zone the lower the number the greater the liklihood of benefit. The deeper the soil the less likely a benefit from fertilizers:- the shallower the more likely a positive response.

Water Analysis may be helpful particularly for sulfur. If water has over 10 ppm Sulfate it contains 9 lbs S per acre foot. There is little liklihood of S deficiency rarely occurs if stream or pump waters over 10 ppm SO_4. However using pure mountain waters with less than 2 ppm SO_4 or 1.8 lbs/Ac foot we see S deficiency since hay must get 30-40 lbs/S portion for normal growth.

Field Fertilizer experiments are usually necessary to determine under local conditions the most economic amounts of fertilizers to be applied. Plant symptoms, plant analysis and soil analysis tell us what nutrients we need to add as fertilizers but as yet no substitute has been found or well laid out tests and demonstrations to show how much fertilizer may be profitably used.