# SOIL AND PLANT TISSUE ANALYSIS FOR EFFICIENT ALFALFA PRODUCTION

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Papers dealing with this subject are found in previous proceedings (W E Martin & R L Luckhart, 1971; Roland D Meyer , 1975). Both papers deal with pounds of nutrient removed in an alfalfa crop; with change in yield associated with an increase in nutrient content; and with critical and adequate levels of nutrients in plants and soils. Salinity - pH - sodic evaluations of soils and water in alfalfa production have been dealt with (Herbert Schulbach, 1975).

Today I intend to discuss the role analysis plays in our recommendations for alfalfa production. In our work we use three types of samples--soil, plant, and water.

Soil samples generally represent the top foot of soil profile, with about 8 cores collected per sample. Often a separate subsoil (2nd foot) sample is also taken.

Plant samples consist of twenty stems (leaves included), with tip, mid-section and base portions retained as a composite sample. Stems can be taken from windrows, so long as they aren't moldy and haven't lost leaves. We analyze these plant samples routinely for total N, $PO_4$-P, K, Zn, Mn, Ca, and Mg. We sometimes analyze for B, Cl, Na.

Routinely we analyze soils for bicarbonate P, for acetate-extractable K and for DTPA-extractable Zn. Saturation extracts are analyzed for electrical conductivity, chloride, sulfate, sodium, calcium-plus-magnesium and estimated exchangeable sodium percentage. They may also be analyzed for bicarbonate and boron.

Water samples are analyzed for the same constituents as the soil saturation extracts.

In preparation for planting alfalfa, soil and water samples are both useful. Our guidelines for interpreting soil analysis results are summarized in Table 1.

For red soils and other very-low-P soils we have to retain at least 100 lbs $P_2O_5$ in the top 3 or 4 inches of soil to assure a reasonable initial root development. Where such soils are capable of high yields, initial fertilization above 200 lbs $P_2O_5$ may be advisable. In most weak or deficient soils it pays to build a strong banded level of P and K at 6-18" depth.

Second-foot soil samples are often lower in potash, zinc and phosphate than surface samples. Where possible, we base the potash application rate on the average level found in the top two feet.

Where sulfate is low in the top foot, the sulfate level may be two to four times as high in the second foot. Good growth of young alfalfa there requires light sulfate applications to the surface. Mature alfalfa shouldn't need sulfur treatment in the case of reasonable levels in the second foot.

Some heavy soils (South Yolo County, West Sutter County) lose sulfate early in the fall and may slowly regain it in the spring. Seasonal sulfate correction may pay off, specially with shallow profiles.

TABLE 1 . Satisfactory and Unsatisfactory Soil Levels with Correction Required for Unsatisfactory Levels

| Nutrient or Parameter | Satisfactory Level | Unsatisfactory Level | Correction Required |
|---|---|---|---|
| Potash * | >240->350 lbs K<br>(65 - 90 ppm K) | <175-<240 lbs K | 150-400<br>lbs $K_2O$ |
| Phosphate | 75 lbs P<br>(20 ppm P) | 30 lbs P<br>(8 ppm P) | 100-200<br>lbs $P_2O_5$ |
| Zinc | .65 ppm Zn | .4 ppm Zn<br>(pH > 7) | 10 lbs Zn |
| Sulfate | 1 meq/l<br>(16 ppm S) | .5 meq/l<br>(8 ppm S) | 80-150 lbs<br>Soil S |
| pH | 6+ | <5.5 | lime to<br>pH 6-6.5 |
| ESP | | >5<br>(& Na > Ca+Mg) | If pH > 6.5:<br>Gyp @ 1 ton/<br>5 ESP units<br><br>If pH < 6.2:<br>Lime at same<br>rate as gyp |
| Cl | 8 meq/l | 15 meq/l | leach |

* Potash and phosphate unit is lbs K or P per acre-foot of soil. Higher level given in each bracket for potash is level required in soils with high exchange capacity (15 meq), high free lime content, or high magnesium level.

Plant samples can be helpful in adjusting your fertilization or soil amendment program during the life of the crop. Normally the plant is sampled at its cutting stage (1/10 bloom). Second or third cutting samples have the advantage of showing nutrients taken up by a plant growing at a maximum rate, before stress from heat or dryness.

Areas low in plant K at the second cutting should receive broadcast potash after the third cutting to reduce stress on the plant in the fourth and fifth cuttings. (Most of the soils we work give reasonable response to potash in the cutting following irrigation.) Some growers prefer to sample plants mid or late summer and scratch or shank in phosphate and/or potash in the fall. We encourage growers to locate low phosphate areas every other year and apply supplemental phosphate that fall.

Plant analysis guides approximate those reported by Martin. For second cutting levels, whole tops may be rated as found in Table 2.

As Martin and Meyer have warned, one must correct all other deficiencies in a plant before one can then accurately evaluate the status of a given nutrient through leaf analysis. This is why soil samples, properly taken, can provide considerable insight into selecting limiting factors in plant uptake.

TABLE 2 . Nutrient concentrations in Alfalfa Tops at Different Levels of Nutrient Sufficiency

| Sufficiency Level | $PO_4$-P | K | Zn |
|---|---|---|---|
| Very deficient <70% Yield; Visible symptoms | <.065% | <.8% (.55% stems) | |
| 90% Yield | .09% | 1.3% (1.1% stems) | 12 ppm |
| Strong (no advantage to being above this level) | .13% | 1.8% | 20 ppm |

We do not run sulfate in tissue any more, because sulfate in the soil extract can be determined much more readily. We are not aware of sulfur deficiency occurring in alfalfa in which soil sulfate is not low

Critical levels for zinc in alfalfa are not exactly defined. The critical leaf level (90% yield level) for zinc approximates 14 or 15 ppm.

In some special cases any of the following elements may also be considered: copper, cadmium, molybdenum.

Despite the large amount of experimental work already done in alfalfa potash and phosphate fertilization, there is a lot of information gotten from trying various rates and application techniques for phosphate under local conditions (soil, irrigation, variety).

As alfalfa feed or nutritional value becomes of greater concern to the grower, a new range of critical values may take precedence over those reported here. This probably would be specially true of the main protein constituents: nitrogen, phosphorus, and sulfur.