SOIL AND FERTILITY MANAGEMENT

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Alfalfa is a high producing, labor intensive, high cost and high return crop. Therefore, it only makes sense not to limit its production or longevity by establishing it on unsuitable soil or by the use of unsound fertility practices. It is the aim of this paper to propose practices which will not limit the production of alfalfa, but, also allow it to be done as efficiently as possible with only the necessary inputs.

Soil

Alfalfa is a deep, taprooted plant that makes its vegetative production from stem growth from the plant crown. Therefore, the best soils for alfalfa production are deep, well-drained soils with a medium texture and brightly-colored subsoils. These soils store high amounts of water and won't put alfalfa under adversely wet conditions. Soils which fall in this group include Pembroke, Maury, Decatur, Elk and Memphis series. These types of soil more or less guarantee that the soil will not limit production. If these soils are available to a farmer, he should give high priority to establishing alfalfa on them. Alfalfa performance on deep, well-drained soils is superior because the subsoil pH is not lower than 5.5 and excess water doesn't remain in the profile for a long time. Excess water kills alfalfa both by impeding aeration anytime and by causing heaving during the winter.

Even though the deep, well-drained soils are most desirable, rather good growth can be obtained with high fertility and good management on shallower soils, well-drained alluvial soils and soils with pans at depths of two and-a-half feet or greater. Such soils include the Eden, McAfee, Huntington, Collins, Zanesville, Mercer, and Grenada. Kentucky has a rather large acreage of soils which are not prime alfalfa soils but will support good alfalfa growth. If alfalfa is established on these soils, additional management is required. The soils with a pan that are only moderately well-drained will grow alfalfa successfully if adequate surface drainage is provided. Heaving can be a problem, especially during the first year of production on these types of soils. This could probably be reduced by spring seeding. This would give the alfalfa a chance to establish a more extensive root system before winter. The acidity of the subsoils of these soils as well as shallower soils is important. Subsoils with extreme acidity effectively reduce root growth. Fields with long histories of good liming programs tend to have subsoils that are not acid. A good combination of drainage and pH substantially improves the success of alfalfa on pan soils.

The chances of successful alfalfa production are reduced on poorly drained soils such as Henry, Taft, Melvin, and Purdy. Soils subject to flooding would not be considered suitable.

Fertility

One of the most important links to a good fertility program is a proper pH. A pH of 6.5-7.0 gives an optimum range for activity of nitrogen-fixing bacteria and the availability of plant nutrients in the soil. Having the pH properly adjusted is especially important for stand establishment and for long-term maintenance of the stand. If the pH is below 6.0, there may be toxic amounts of aluminum and manganese that can interfere with alfalfa root growth. Keeping the pH above 6.0 removes the problem, but molybdenum may still be limiting. If the pH is not at least 6.2 at time of seeding, apply one pound of sodium molybdate (6.4 oz. of Molybdenum) per acre. Since molybdenum is not mobile in the soil, it should be incorporated.

All legumes, including alfalfa, are especially responsive to phosphorus, and available phosphorus levels in the soil should be built to the high level and maintained there for prolonged high production. Responses to potassium is more dependent on soil type. Responses to potassium have been found consistently on Maury and Tilsit soils, but are not as dependable on soils like Pembroke and Eden. Soil testing will help in this respect.

Seasonal removal of phosphate (P_2O_5) and potash (K_2O) from the soil by a high yielding crop (5-6 tons hay/ac) is on the order of 75-100 pounds P_2O_5 and 300-400 pounds of K_2O per acre. This is why it is so important to maintain a high level of these nutrients in the soil. There are basically two approaches which can be taken to providing these high fertility needs in the soil. One way is to rapidly raise soil test to high by a large application of phosphate and potash, then maintaining it there with lower annual topdressing rates made largely to compensate for the difference between plant removal and what the soil can naturally supply. The other approach would be to fertilize each year on the basis of existing soil test levels. This program would require higher annual topdressing rates than the first approach. The U. K. College of Agriculture fertilizer recommendations are:

Phosphate and Potash (Higher rates will be necessary to get immediate build-up of soil test levels.)

Soil Test Level	New Seedings lbs/a		Established Stands* lbs/a	
	P_2O_5	K_2O	P_2O_5	K_2O
High (over 60P, 250K)	0	0	0	0
Medium (60-30P, 250-165K)	0-100	0-100	0-100	0-100
Low (less than 30P, 165K)	100-160	100-160	60-120	160-240

*For yield goals over 4 T/A, increase P_2O_5 by 30 lbs/a and K_2O by 60 lbs/a.

There is always the question of when to put the fertilizers on and if it should be split. Dr. Bill Thom carried out an experiment near Elizabethtown on a Sonora soil to help answer these questions.

Time of Fertilizer Application* 1	2	Yield of Hay (12% Moisture) 1980	1981	1982	Avg.
		---------- Tons/ac			----------
Fall (100%)		7.6	8.3	6.0	7.3
Fall (50%)	Aft. 1st Har. (50%)	7.8	8.2	6.2	7.4
Early Spring (50%)	Aft. 2nd Har. (50%)	7.5	8.1	5.8	7.1

*Initial soil test was medium in P and K.

The differences are small, although there does appear a small advantage to applying some or all of the fertilizer in the fall. The overriding factor is that the fertilizer is applied.

Soil tests are very important in determining the amount of applied fertilizer on the maintenance of a stand. The average removal for a ton of alfalfa hay is about 14 bls/a of P_2O_5 and 45 lbs/a of K_2O. However, the additions of these "maintenance" amounts of fertilizer will probably not stabilize the soil test. This is due to the complex nature of soils. Therefore, soil test themselves become the overriding factor in the fertility program.

Effect of applied and removed P_2O_5 and K_2O on soil tests before and after 6-years of alfalfa production on a Pembroke soil.

P_2O_5/yr. Applied	P_2O_5/yr. Removed	Soil Tests: Before Study March 1970	Soil Tests: After Study March 1976	Avg. Hay Yield
lbs/ac	lbs/ac	lbs/ac	lbs/ac	T/a/yr.
0	64	55	21	5.65
90	82	55	97	6.23
135	82	55	145	5.98
180	85	55	155	6.05
K_2O/yr. Applied	K_2O/yr. Removed	Before Study March 1970	After Study March 1976	Avg. Hay Yield
lbs/ac	lbs/ac	lbs/ac	lbs/ac	T/a/yr.
0	318	240	145	6.07
100	368	240	195	6.33
150	379	240	260	6.48
200	382	240	363	6.13

The above table is from work done by Wells, Vaught and Driskill in Warren County. As you can see, the soil tests stabilized at a high level when fertilizer application rates were below the nutrient removal rate. It will depend a lot on the soil. Consequently, fertilizing by soil test is more accurate than using maintenance fertilizer based on the amount of hay removed from the field.

Boron availability is often a limiting nutrient for alfalfa production, and alfalfa should receive 1.5-2.0 pounds of elemental boron (B) per acre per year. There is no universal response to boron in Kentucky but it is cheap insurance.