EXPERIENCES WITH FERTILIZER APPLICATION ON ALFALFA GROWN FOR THE ALFALFA DEHYDRATING INDUSTRY IN N.E. SASKATCHEWAN

D.A. Pulkinen
Alfalfa Dehydrators Research Laboratory
Tisdale, Saskatchewan

Introduction

The use of P, K and S fertilizers for alfalfa production has been researched extensively in certain parts of North America. Work on alfalfa fertilization has largely been conducted in the United States, and to a lesser extent in regions of Canada where alfalfa production is considered to be of importance. The availability of research information in Saskatchewan is much more limiting, especially for the N.E. region of the province where alfalfa is grown to a large extent for the dehydrating industry. Information is available on the effects of fertilization on yield response, but very little is known about its effects on forage quality and stand persistence as related to the type of management that alfalfa is subjected when grown for artificial dehydration.

During the past 5 years, the alfalfa dehydrating industry has conducted investigations to determine the effects of fertilizer application on yield response, forage quality and stand persistence in the North East. Some of these investigations are presented in this paper.

Experimental and Results

Sites were selected where deficiencies of one or more of the major nutrients existed in the soil. Alfalfa was established along with a wheat companion crop in plots measuring 4 ft x 16 ft in a randomized complete block design containing 4 replicates. Fertilizer was applied to the alfalfa according to recommended practices. The wheat companion crop received recommended levels of fertilizer except as where otherwise specified. The wheat was harvested in the year of establishment, followed by harvest of alfalfa forage in subsequent years. Normally, 2 cuts of alfalfa were taken each year, except where sufficient growth allowed for a 3rd cut to be taken late in the fall.

Study 1:

A fertilizer trial was established in 1973 on Tisdale SiC-SiCL soil containing 75 lb P and 665 lb K in the 0-6" soil depth, and 27 lb SO_4-S in the 0-24" depth. 10 lb S as 16-20-0 was applied with the alfalfa seed; while the wheat required no fertilizer. The results are presented in Table 1.

Table 1: Response to fertilizer application on alfalfa grown on Tisdale SiC-SiCL established in 1973 (Data for 1974-77)*.

	Check	Fertilized**
D.M. Yield (t/ac)	9.84	10.56
% Crude Protein (4 yr. ave.)	19.0	19.1
% Stand (Sprin '77)	87	83

* 1 cut only harvested in 1977
** 71 lb/ac of 16-20-0 (S) applied at seeding in 1973

Application of fertilizer increased alfalfa yields by 0.7 t/ac during the lifetime of the stand. No differences in forage protein content nor % stand after 4 years were observed. Soil samples taken from the fertilized plots in the spring of 1975 contained 28 lb P and 435 lb K in the top 6"; while the 0-24" depth contained 58 lb SO_4-S/ac. One can only speculate as to whether the yield increase was due to the sulphur or the phosphorus, or both. Nevertheless, an economic yield response was obtained based on alfalfa forage valued at $ 20/t and 71 lb/ac of 16-20-0 @ $ 130/t.

Study 2:

In the spring of 1976, a study was established south of Choiceland on Kamsack SiL containing 15 and 280 lb/ac of P and K respectively (top 6" of soil) and 33 lb SO_4-S in the 0-24" depth. 60 lb N and 35 lb P_2O_5 was applied for the wheat companion crop on all treatments. The alfalfa was fertilized as described in Table 2 according to soil test recommendations.

Table 2: Response to fertilization of alfalfa grown on Kamsack SiL established in 1976.

		Check	P	P & S	P; P & K
Fert. (lb/ac)	Spr. 1976	-	25 P_2O_5	25 P_2O_5; 11 S	25 P_2O_5
	Fall 1977	-	-	-	30 P_2O_5; 40 K_2O
D.M. Yield (t/ac)	1977	2.33	2.65	2.74	2.65
	1978	3.03	3.35	3.31	4.17
	Total	5.36	6.00	6.05	6.82
% C.P. (2 yr ave.)		16.1	16.3	16.4	16.4
% C.F. (2 yr. ave.)		28.2	28.1	28.1	29.3
%.Stand (Spr. '78)		91	88	89	84

Application of P in 1976 increased alfalfa yields by 15% in 1977. P & S gave a small, but non-significant increase as compared to application of P alone. A second application of fertilizer (P & K) in the fall of 1977 dramatically increased yields in 1978 (38% increase over the check). Protein content in the forage was similar for all treatments, although there was a tendency for slightly higher protein in the plots receiving fertilizer. Average crude fiber levels for the 2 years were similar for all treatments, with the exception of plots receiving a 2nd application of fertilizer in 1978 being higher in crude fiber content. Although the data for each individual year is not presented, the higher fiber level was attributed entirely to the forage harvested in 1978, which was approximately 2 percentage points higher than all other treatments. The slightly lower percent stand in the fertilized plots may have been due to some seedling injury caused by the fertilizer; as these differences were already apparent after emergence in 1976. All the phosphate applied for the alfalfa (25 lb P_2O_5 as 11-48-0) was placed with the seed. These levels were higher than what is normally recommended for seed placement. However, since soil moisture conditions were excellent at time of seeding, it was felt that seedling injury should not occur at this rate of application.

It's of interest to compare relative yields of plots receiving the initial application of 25 lb P_2O_5/ac with the check plots on a per cut basis over the first 2 years of harvest (Figure 1). Residual P responses were maintained for the 1977 harvest. However, in 1978 yields decreased relative to the check plots until no real differences were evident in the 2nd cut. In the fall of 1978 the check plots contained 6 lb P/ac in the top 6" of soil, while the fertilized plots contained 5 lb P/ac.

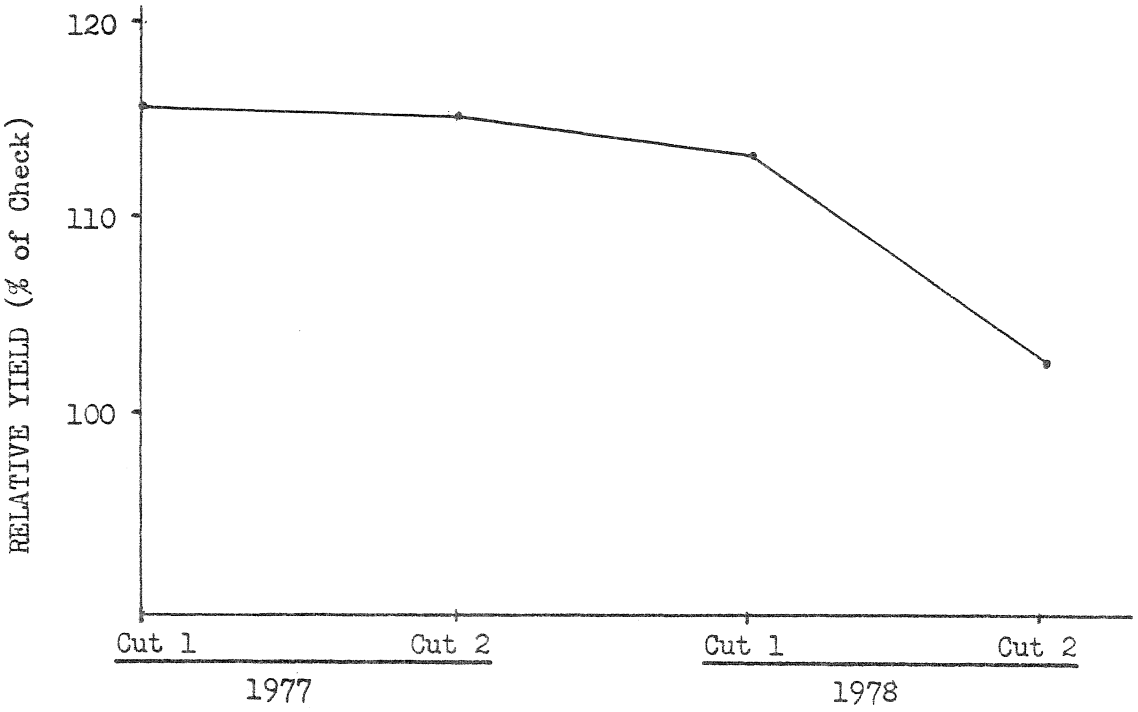

Figure 1: Residual P response to alfalfa established in 1976 on Kamsack silty loam.

Study 3:

A second site in the Choiceland area was established in 1976 on Kelsey VFSCL where deficiencies of both potassium and sulphur were present. The various fertilizer treatments and data from the harvests are presented in Table 3a.

Table 3: Fertilizer application on alfalfa established on Kelsey VFSCL in 1976.

a. Harvest data

		Check	K & S	K & S
Fertilizer (lb/ac)	Spr. '76	-	30 K_2O & 10 S	30 K_2O & 10 S
	Fall '77	-	-	83 K_2O & 20 S
D.M. Yield (t/ac)	1977	1.01	0.94	0.88
	1978	2.36	2.36	2.41
	Total	3.37	3.30	3.29
% Crude Protein (1977 & 1st Cut 1978)		16.4	16.7	16.1
% Stand (Spr. '78)		98	95	94

b. Soil nutrient data

	Spring '76	Fall '77	Fall '78		
		Fertilized	Check	Fert.'76	Fert.'76&'77
P (0-6"), lb/ac	31	22	21	14	17
K (0-6")	200	150	115	100	105
S (0-24")	21	10	7	8	8

We were unable to elicit yield responses, even with fertilizer application for 2 successive years. No differences in average forage protein content were evident; although the 1st cut forage harvested from the fertilized plots in 1977 contained almost 1 percentage point higher protein as compared to the check. Analysis of the soil (Table 3b) indicated that we were unable to maintain or improve soil nutrient levels based on levels of nutrients applied.

Study 4:

In 1977 a series of trials were established on heavy textured soils in the Arborfield area to determine responses to various rates of phosphorus applied to phosphorus deficient soils. The three locations consisting of Tisdale HvC, Weirdale SiCL and Arborfield SiC soils, contained an average of 12 lb P/ac in the top 6" of soil. Other nutrients for alfalfa were adequate, with the exception of potassium being required at one location at the rate of 40 lb K_2O/ac. The various fertilizer applications, the

1977 wheat yields and 1978 alfalfa yields are presented in Table 4.

Table 4: Response to phosphate fertilizer on heavy textured soils at Arborfield (Average of 3 locations).

	Lb P_2O_5/Ac.	1977 Wheat Yield (bu/ac)	1978 Alfalfa Yield (t/ac)	Cut 1 Protein (%)	Fall '78 Residual P(0-6") (lb/ac)
1.	-	30	2.74	18.5	6
2.	25W	37	3.13	19.0	12
3.	25W + 25A	37	3.20	18.7	12
4.	25W + 50A	45	3.30	19.2	16
5.	25W + 75A	42	3.27	19.4	23

W: wheat A: alfalfa
25 lb N/ac was applied for wheat in Treatments 2-5 inclusive.

Wheat yields increased in proportion to the total phosphorus (wheat plus alfalfa) applied to the plots up to a level of 75 lb P_2O_5/ac. Similar yield patterns were observed for the alfalfa harvested in 1978. The largest yield increment for the alfalfa was obtained when 25 lb P_2O_5 was applied for the wheat. Additional phosphorus for the alfalfa resulted in proportionately diminishing yield increments. No marked differences in forage protein content were apparent, although fertilized plots tended to produce slightly higher protein forage. Residual $NaHCO_3$-P levels in the soil in the fall of 1978 were in proportion to the amounts of phosphorus applied to the plots. Only the highest rate of application contained adequate extractable P levels according to current nutrient requirement guidelines; while the 2nd highest application rate was borderline.

Conclusions

The primary purpose of the investigations was to demonstrate the benefits of providing adequate levels of soil nutrients for the production of alfalfa. While most of these investigations have not been completed, they do suggest certain important implications. Firstly, substantial alfalfa forage yield increases are possible through adequate soil fertility management, particularly when adequate soil moisture conditions are prevalent, as is commonly found in the North East region of the province. In order to optimize yields, it may be necessary to apply fertilizer at rates that are higher than those currently recommended, particularly in lighter soils. This is particularly true for phosphorus, when considering that phosphorus is normally applied at establishment to meet the requirements for 3-4 years of alfalfa production. Secondly, since alfalfa is normally established with a companion crop, soil fertility should be looked upon from a total crop management viewpoint. Failing to do this, growers may not be realizing the fullest potential of both the companion crop and the alfalfa that is to be harvested in subsequent years. With respect to forage quality, the use of proper fertilization practices to increase