NE U.S./E CANADA

Potassium Responses in Northern Forages

By Thomas W. Bruulsema and Jerry H. Cherney

Research has confirmed K needs for economically optimum yields of northern forages.

Alfalfa

An alfalfa K response trial was conducted in Aurora, NY, by S.D. Klausner of Cornell University from 1988 to 1992, continuing a series of soil test calibrations. Six annual rates of K were applied on a silt loam soil testing low in K (69 lb/A). The most economic rate[1] for the four years' production was an annual K_2O application of 260 lb/A, compared to a previous recommendation of 110 lb/A. Recently, New York recommendations for medium textured soils testing low to medium in K have been increased. The most economic rate of K application varied little among the four production years. However, responses increased as the stand aged.

Northern forages require potassium (K) for optimal yields, but K concentrations in ruminant diets warrant attention. Best management uses soil testing and forage analysis to ensure high yields and persistence. Liming, timing of harvests, species, varieties and age of stand all influence K management in forages.

Alfalfa responses in soils with high K test levels were recorded by Dr. D.B. Beegle at two sites in Pennsylvania. Although there was no response the first year, in the second and third production years the most economic rate of K fertilizer increased to 110 and 190 lb/A at Rock Springs and 200 and 260 lb/A at Landisville. The critical K concentration in forage for avoiding yield losses appeared to be between 2.5 and 2.8 percent.

Intensive alfalfa management research was conducted in Ontario by Dr. R.W. Sheard from 1984 to 1986. In the second production year (1986) of a five-cut management system, yields showed a small response to K even though soil test levels were high. In both 1985 and 1986, forage K concentration was increased by fertilizer K. The 1986 response suggested a critical level of 2.7 percent.

TABLE 1. *Response of reed canarygrass to annually applied N and K in Connecticut.*

K_2O applied, lb/A	Fertilizer N, lb/A 100	200	300	Fertilizer N, lb/A 100	200	300
	Hay yield, tons/A			K concentration, %		
0	3.6	5.1	5.5	1.73	1.02	0.86
200	3.6	5.9	6.9	2.86	2.73	2.46
400	3.5	5.7	6.7	3.07	3.22	3.20

Allinson, et al.

[1] *Economically optimum rates mentioned in this article assume a price ratio of 3 lb hay per lb of K_2O for alfalfa; 3.75 lb hay per lb of K_2O for grass.*

Forage Grasses

A Connecticut experiment on nitrogen (N) and K responses of reed canarygrass was established in 1983. The soil was a Paxton fine sandy loam with soil test K of 240 lb/A. Initial rates of both N and K_2O were 0, 200 and 400 lb/A for the first two years, during which there were significant responses to N but not to K. From 1985 through 1988, N rates were changed to 100, 200 and 300 lb/A, maintaining the same three K rates. During those four years there were consistent responses to K at the higher levels of N (**Table 1**). Economically optimum rates of N and K_2O were 300 and 200 lb/A, respectively, at which forage K concentration was below 2.5 percent.

Fertilization of mixed grass sods on Bangor and Monarda silt loam soils in Maine produced strong responses. At the optimum N rate of 200 lb/A, an economic response up to 150 lb/A of K_2O was measured (**Table 2**). At that rate of K fertilization, first cut grass averaged less than 2 percent K.

TABLE 2. *Response of grass hay to K in Maine averaged over two locations and three years.*

K_2O applied lb/A	Hay yield, tons/A	K concentration, %
50	3.6	1.37
150	4.1	1.90
300	4.2	2.56

45% timothy, 45% quackgrass, 10% bluegrass.

Brown, et al.

Potassium has traditionally been recognized as essential for persistence of legumes in legume/grass mixtures. Research in New Brunswick has shown that it is also essential for persistence of grasses such as timothy.

On acid soils, application of lime increased forage yields and decreased forage K concentrations (**Table 3**). Dolomitic lime was particularly effective in affecting the ratio of K to magnesium (Mg). Higher Mg concentrations in forage are important in reducing the potential for grass tetany, but K supplies must be monitored to be sure that higher yield potentials can be achieved.

Management Considerations

Potassium responses in both legume and grass forages increase over time as the stand ages. There are several reasons for this:

- higher availability of soil K induced by tillage at establishment
- uniform incorporation of initial K application before seeding
- ability of forages to exploit K deep in the soil

As soil K is rapidly depleted by large removals, the forage crop relies more strongly on annual surface applications of K fertilizer. Split applications of K may help. When all the K is applied in the spring, the first cut tends to have high K.

The relationship between protein and K concentration in forage is important. Potassium is essential both as a counter-ion for nitrate (NO_3^-) uptake, and for the conversion of soluble N compounds into proteins.

Summary

Management that both maximizes economic yield and optimizes forage K concentration requires close monitoring of both plant and soil. Regular forage analysis helps to evaluate the fertilizer program as well as to determine feed management. Soil testing should be at least an annual event. BC

Dr. Bruulsema is Director, Eastern Canada and Northeast U.S., PPI, Guelph, Ontario. Dr. Cherney is Professor, Forage Management/Utilization, Cornell University, Ithaca, NY.

TABLE 3. *Use of calcitic or dolomitic lime to raise soil pH to 5.7 can reduce forage K concentrations.*

Forage species	Forage K concentration, % No lime	Calcitic lime	Dolomitic lime
Perennial ryegrass	3.4	2.7	2.7
Tall fescue	2.9	2.5	2.4
Orchardgrass	3.6	3.1	2.9
White clover	3.9	2.6	2.7
Red clover	3.5	2.1	2.4

Piers, et al., Purdue