Introduction

Proper fertilization practices are essential to obtain maximum alfalfa yields for the current season and for seasons to come. Additions of phosphorus (P) and potassium (K) fertilizers are essential, but timing of applications may be as important when trying to maximize efficient use of both nutrients. The following data discussed was derived from an alfalfa stand over a four-year period. Soil tests taken at the onset of this study were 5 ppm P and 90 ppm K. Plots were supplemented with four P treatments (0, 50, 100, and 150 lbs P$_2$O$_5$/acre/year) and five K treatments (0, 100, 200, 300, and 400 lbs K$_2$O/acre/year).

Yield

Additions of P and K fertilizer substantially increased yield in each of the years of this study (Figs. 1 and 2). Over the four years, total forage yield increased 4.17 tons/acre with P and 2.15 tons/acre with addition of K.

Yield increases have been due to increased mass/shoot. Shoots/plant has not been affected by fertilization. Plant population has actually decreased with application of P (Fig. 3) and remains unaffected by K additions. Additions of P are promoting bigger and more robust alfalfa plants. Although there are fewer plants, they produce greater biomass and sustain economically viable stands to 5 years or more.

Why is it important to know mass/shoot is driving yield increases with increased fertilization? Many extension bulletins will tell you that stands of 40 shoots/ft$^2$ or below are not viable, and that this is the critical value of ending a stand. In our study shoots/ft$^2$ in plots receiving 150 lbs P$_2$O$_5$/acre/year have not been above 40 shoots/ft$^2$ since May of 1999, but yet these plots have produced the highest dry matter yield in each year. When accessing an alfalfa stand, be aware that mass/shoot can support high yields even in lower populated stands.

Seasonality of K Response

Over the past four years, the response of yield due to K fertilization has been seasonal. In Harvest 1 of each year, yield differences due to K additions have not been detected, but by Harvest 4 K deficiency is acute (Fig. 4). The seasonality of K response is thought to be from the freeze/thaw cycles that the soil experiences throughout the winter and early spring. These cycles may release K previously bound between soil clay particles and inaccessible to the plant. This release of K may sustain growth in Harvest 1 of each year, but as subsequent harvests are performed, K availability becomes limited once again.

In the aspect of fertilizer management, this has two very serious implications. First when soil sampling, be aware of when the sample was taken. Tests performed in the spring may produce falsely inflated values of available K in the soil. Also caution
should be taken when comparing a recent soil test with past tests. Comparisons between soil tests taken in the fall with tests performed in spring will not relate how the management practices between soil tests are effecting soil concentrations of K. Secondly application of K should occur after Harvest 1. Any addition of K before Harvest 1 may not maximize K fertilizer efficiency because of luxury consumption of K. This over consumption of K may result in subsequent harvests experiencing K deficiency.

**P and K Removal Rates**

Removal of P and K from the soil has been substantial (Fig. 5). While annual K removal has been as much as 400 lbs. K$_2$O/acre, P removal has been just below 100 lbs. P$_2$O$_5$/acre while removing 7 tons of dry forage/acre. To replace the extracted nutrients, 100 lbs of potash (0-0-60)/ton of forage removed/acre and 30 lbs of triple superphosphate (0-46-0)/ton removed/acre is required. Application of lower amounts of K and P will potentially create a deficient situation in the soil that could limit the maximum forage production in subsequent harvests.

**Key Points for Alfalfa Fertility Management**

- Each ton of hay removes 100 lbs. of potash (0-0-60) and 30 lbs. of triple superphosphate (0-46-0).
- Soil test in summer or autumn so samples better reflect plant-available K in the soil.
- Apply half the recommended rate of fertilizer specified by your yield goal after the 1st cutting in May/June and the remaining half after your last cutting in September.
Figure 1. Total dry matter yield as influenced by phosphorus (P) fertilization. Addition of P increased dry matter yield in each year.

Figure 2. Total dry matter yield as influenced by potassium (K) fertilization. Addition of K increased dry matter yield in each year.
Figure 3. Influence of P fertilizer application on plants/ft$^2$. Data are averaged over the K fertilizer treatments. Additions of P$_2$O$_5$ decreased plant populations in each sample date.

Figure 4. Effect of addition of K in Harvest 4 of 2000 and Harvest 1 of 2001. In Harvest 1 of 2001 no effect of K fertilization was observed in the previous fall; yield was increased with additions of K.
Figure 5. Removal of P and K by additions of both nutrients. Removal of P never exceeded 100 lbs. P\textsubscript{2}O\textsubscript{5}/acre application rate. When supplied any amount of P, removal of K exceeded each application rate even in plots receiving 400 lbs. K\textsubscript{2}O/acre.