

Topdressed K for Last-Year Alfalfa May Not Pay

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Alfalfa is the 4th most widely grown crop in Minnesota, after corn, soybean, and wheat. Although alfalfa acreage is 20% smaller than wheat acreage, dry alfalfa hay production alone (excluding haylage) nearly equals wheat in value.

Benefits of including this short-lived perennial legume in crop rotations are well known, but often are not given sufficient credit. Benefits include improved water quality, less soil erosion, enhanced soil tilth and carbon storage, greatly reduced fertilizer N need for subsequent crops, interrupted life cycles of insect and disease organisms that reduce row crop yield, and high profitability.

However, in Minnesota alfalfa yields have been stagnant at ~3 tons/ac, much lower than alfalfa's yield potential. Many top alfalfa producers regularly harvest 5 tons/ac, and yields of 6-7 tons/ac are common in the University of Minnesota alfalfa variety testing program, which uses high levels of soil fertility and pest control.

Soil fertility affects both yield and quality of alfalfa. Nutrient removal can be very high, because nearly all the above-ground portion of the crop is removed at each harvest. Potassium (K) plays a critical role in crop yield by moving sugars from shoots to roots, and then back again during regrowth.

Potassium availability also is crucial for optimum stress tolerance. Alfalfa is stressed by multiple harvests, field traffic, poor drainage, drought, and winter conditions. In order to improve crop tolerance to these stresses, University of Wisconsin Extension recommends increasing K rates by 20% if stand life longer than three years is desired. On the other hand, excessive K fertilizer can result in high forage K concentration, which can cause problems as dry cow feed.

In Minnesota, K fertilization is recommended for alfalfa, regardless of yield goal, on soils testing in the medium range (81-120 ppm K). Recent increases in K fertilizer price raise the issue of bottom line returns. Whether producing dairy-quality hay or biofuel feedstock, it is imperative that farmers apply the most economic rate to maximize profit.

The question asked in this research was – *From the point of view of alfalfa response (yield and quality), what K rate should be applied in the last growing season to provide the maximum marginal return?*

METHODS

Research was conducted on six farms in 2008 and on five in 2009 to measure alfalfa response to topdressed K (Figure 1). Each had an average soil test of exchangeable K that was in the medium range (<125 ppm K), indicating that the crop is likely to respond to K. University of Minnesota recommends applying 100-140 lb K₂O/ac to alfalfa with these soil tests for a 6 ton/ac hay yield goal. Soils ranged from sandy to clay loams. One site was irrigated.

On eight farms, K was applied after the 1st harvest. On the remaining three farms, K was applied in early spring as the crop began to grow. Rates of 0, 20, 50, 100, and 200 lb K₂O/ac were broadcast-applied to 3 or 4 replicates in each field. Replicates were blocked to account for apparent or expected in-field variability. The entire plot area was fertilized with P as needed based on topsoil test results and University of Minnesota recommendations.

Before each subsequent harvest, two 1-m² (10.8 ft²) samples were collected from every plot. Herbage was oven dried, weighed, and ground. Subsamples from 2008 were analyzed for quality components by near-infrared spectroscopy (NIRS). The NIRS predictions for protein, ADF, NDF, and NDFD were adjusted based on wet chemistry measurements on a subgroup of samples. RFQ and RFV for each were calculated based on standard equations.

Results from Farm CH were omitted after intensive soil sampling showed that soil test K levels were highly variable and generally higher than medium. At another site, some plots were lost due to inadvertent traffic, but data from remaining plots were included.

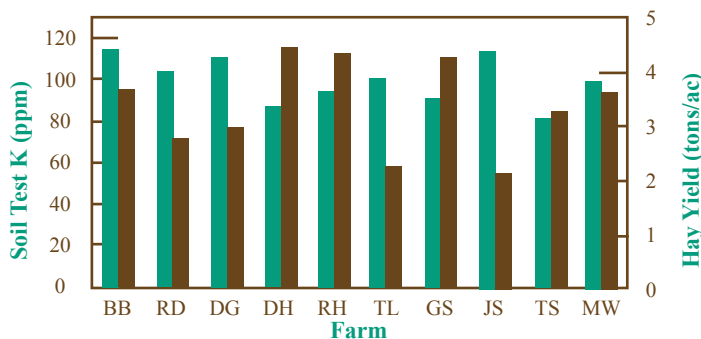
RESULTS

Yields differed among farms at every harvest, which was expected because the farmers used different harvest schedules. As expected, greater yield was produced with longest regrowth intervals. Total hay yield was not related to initial soil test K level (Figure 2).

Significant yield improvement from topdressed K was not discovered across these farms. This was the case whether K was applied during regrowth in early spring or after the 1st harvest, or whether alfalfa was irrigated or not. There also were no differences in overall forage quality due to K application; for example, RFQ of the forage from the farms in 2008 ranged from 149-273 at 2nd harvest, 174-209 at 3rd harvest, and 185-256 at 4th harvest. Quality generally was inversely related to yield within a given harvest.

The only quality parameter that showed a response to K fertilization was neutral detergent fiber digestibility (NDFD), which

Figure 2. Soil test K and total hay yield on 10 MN farms. Yields are averaged over fertilizer rates (0-200 lb K₂O/ac) because yield did not respond to applied K. Three farms (DH, RH, MW) include 1st harvest because K had been applied in early-spring. Others include only harvests taken after 1st cutting.



increased by 2-3 points to an average of 50% and 47% with 100 or 200 lb K₂O/ac at the 1st and 2nd harvest after fertilization (data from 2008 only). Although small increases in this fiber characteristic can improve DM intake, it is doubtful that a change of this magnitude in a single harvest would improve herd performance. Furthermore, the slight improvement in NDFD that was measured in hand-harvested samples in 2008 may not have been reflected in the crop after typical harvest and storage conditions, which usually reduce forage quality.

The analysis of forage K has been completed at only one site. It was evident that alfalfa absorbed K from the fertilizer, with apparent fertilizer uptake efficiencies (uptake of nutrient/unit of nutrient applied) of over 100% for the 50 lb K₂O rate and 40% for the 200 lb K₂O rate. The lower K rate may have improved soil K uptake by the crop.

Plants often can absorb K in amounts that exceed their need, a process called 'luxury consumption.' In the 1st harvest after fertilization at this site, for example, forage K concentration rose from 1.29% in the control plots to 2.08% at the 200 lb K₂O/ac. This propensity results in forage with high K concentrations, which is especially problematic for fresh cows because it increases the risk of milk fever. The other concern with luxury consumption is that the fertilized crop will leave less K for the following crop, reducing the ultimate fertilizer use efficiency (improved yield/unit of nutrient applied) in the crop rotation.

CONCLUSIONS

From these 10 site-years of on-farm research, the preliminary conclusion is that K application to last-year alfalfa is not economical. Evidence from one site shows that fertilizer K was absorbed by the crop, but more analysis at other sites is needed to be certain that K availability was not limited by dry soil or other conditions. A final project report will be prepared in 2010.

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