NEWS & VIEWS

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Managing Potassium for High Yield Alfalfa

ALFALFA! No other forage can beat its production potential for high yields and its value as a readily digestible protein for livestock feed. To achieve these tremendous potentials, however, alfalfa requires adequate and balanced nutrition.

Alfalfa uses potassium (K) for:

- Controlling the leaf pores (stomates) to use water efficiently
- Moving and converting carbohydrates within the plant
- Enhancing the flow of carbon dioxide into the leaf
- Converting soluble nitrogen (N) to protein

Why is K Management of Alfalfa Important?

High yields of hay require good fertility. Potassium is the nutrient alfalfa needs in the greatest amounts.

Potassium is vital for winterhardiness, stand persistence, and longevity. Generally, because of its deep and extensive rooting habit, alfalfa is able to make good use of soil K for the first few years of the stand. As the stand ages, soil K is rapidly depleted by large removals and the crop relies more strongly on annual surface K applications. The data in **Figure 1** indicate that yield responses to annually applied K tend to increase over the life of the stand, across a wide range of locations. Since economics often dictate that a stand of alfalfa be maintained four years or longer, the large response to K in the third and fourth year should never be neglected.

Note that these later responses resulted from the cumulative effect of annual K additions. Applications before stand establishment and during the first few years contribute to the yield responses in the third year and beyond. On soils testing low or medium in K, large responses occur even in the first year.

How Much K Does Alfalfa Need?

Roughly 30 million acres of alfalfa are grown in North America. On average, the crop receives about 28 lb/A of fertilizer K_2O. The total amount removed at harvest varies from 50 to 75 lb of K_2O per ton of dry matter, but can easily be above or below this range depending on soil K availability.

❖ Soil testing

Soil testing is an essential starting point for determining alfalfa K needs. Use soil-test based recommendations specific to your geographical area. Generally, when soils test in the optimum range, the recommended K rate is the amount you expect the crop to remove. Give credit to the K applied in manure. Liquid dairy manure can be particularly high in K.

Other soil nutrients will also be important. Alfalfa needs a pH level of at least 6.5 for efficient N fixation. A balanced approach will require particular attention to the phosphorus (P), sulfur (S) and boron (B) needs of the crop as well. When high rates of K are applied, the B requirement can sometimes increase.

❖ Forage analysis

There are two good reasons to test harvested forage for minerals, including K.

First, the analysis is useful in determining mineral

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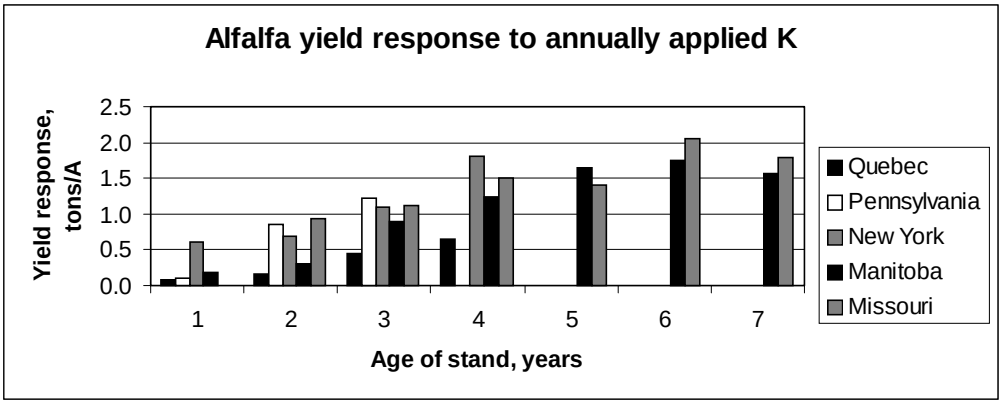

Figure 1. Yield response to potash application gets larger as the alfalfa stand ages.

supplements needed for livestock. Forage calcium (Ca) and magnesium (Mg) levels may decrease when K supply is increased.

Second, forage analysis is also an indication of the fertility you have supplied to your crop. It reflects the K supplied by the soil and fertilizer. Generally, optimum yields are obtained at about 2.5 percent K. Analysis readings below 2 percent indicate the alfalfa plant is not getting enough K for good winterhardiness.

❖ When to apply

New Seedings: It is important to build soil test K to the optimum or high range before seeding, because this is the only opportunity (for the life of the stand) to mix nutrients with topsoil. At planting, some K can be banded below the seed, allowing adequate separation between the seed and the fertilizer band.

Established Stands: The time alfalfa needs the most K is in preparation for winter. In order to boost winterhardiness of the crop, a good supply of K should be applied before the critical fall growth period. Potassium is needed during this period to enhance storage of soluble carbohydrates in the roots. Late fall applications are less effective in increasing winter survival, because the K is not supplied in time. For this reason, applications are best made before the last six weeks of the growing season. After first cut is another convenient time to apply K. If all the K is applied in the spring, the first cut tends to have a high K concentration. When high rates are needed, splitting the amount into two or more applications is recommended, to avoid salt injury.

Alfalfa Responds to K

❖ Yield

Alfalfa responds to high rates of K. As with any other crop nutrient input, the response depends on soil test level and is subject to the law of diminishing returns. Three examples of yield responses are shown in **Figure 2**. These data were obtained from trials carried out for three to four years at each site.

❖ Quality

• Protein, proportion of legume in the hay

When grown in mixtures, forage grasses compete with legumes for K, and usually are more aggressive. When K is limiting, the stand will become grass dominant. To maintain more alfalfa in a mixed stand, it is doubly important to ensure that K fertility is adequate.

• Potassium concentration—luxury consumption

Potassium content of alfalfa forage can easily vary from less than 1.7 percent to more than 3.0 percent. Concentrations below 1.9 percent may be too low to meet ruminant animal requirements. On the other hand, concentrations higher than 3 percent are unnecessary and may be of some concern for animal nutrition. The wide range of K levels in Ontario forages is shown in **Table 1**.

Table 1. Potassium concentration in forage samples submitted for analysis.

Type of forage	Number of tests	Average concentration	Range High	Range Low	Standard deviation
		- - - - - - - - K, % of dry matter - - - - - - - -			
Alfalfa haylage	2,622	2.4	4.3	0.6	0.5
Mixed haylage	5,944	2.4	4.1	0.5	0.5
Grass haylage	464	2.3	3.7	0.6	0.6
Alfalfa hay	944	2.2	3.6	0.4	0.6
Mixed hay	7,151	1.9	3.9	0.1	0.5
Grass hay	924	1.7	3.1	0.3	0.6
Corn silage	4,102	1.0	1.8	0.1	0.2

Agri-Food Laboratories, Guelph, Ontario, 1992-1996.

On farms where large amounts of feed or supplement are purchased, there may be a net import of K onto the farm. Liquid manure systems are very effective in transferring K in dairy cattle manure to the soil, increasing soil K levels.

High K levels can be a concern in forages fed to dry cows. Excessive K in the diet during the last three to four weeks before calving can increase the incidence of milk fever and other related disorders. Lactating cows generally do not have problems with excessive K in their diets. The diet of the lactating cow is generally higher in grains and corn silage, which dilute dietary K. The lactating cow requires a minimum of 1.0 percent K in the diet for optimal milk production. Under heat stress, the optimal level of K may increase to as much as 1.9 percent of the dietary dry matter.

❖ Potassium Response Translates to Profit

The response curves fitted to the data in **Figure 2** show how the rate of K for most economic yield can be estimated. State, regional or site-specific recommendations are built on results from many such trials.

Examples of the net profit that can be gained from using K fertilizer at the most economic rate are shown in **Table 2**. Profitability is highest for soils with lower K levels, but even high testing soils can profit from K application.

Table 2. Annual return to K fertilizer use at the 3 sites in Figure 2, assuming hay at $90 per ton and K_2O at 14 cents per pound (price ratio approximately 3).

Soil test K	K_2O rate, lb/A	Response, ton/A	Net return, $/A
very low	335	1.2	$61.10
low	260	1.0	$53.60
high	90	0.2	$5.40

Summary

Potassium is the nutrient alfalfa needs in the largest amount. Careful management of soil K levels and application of the optimum rate can lead to substantially greater profitability. ■

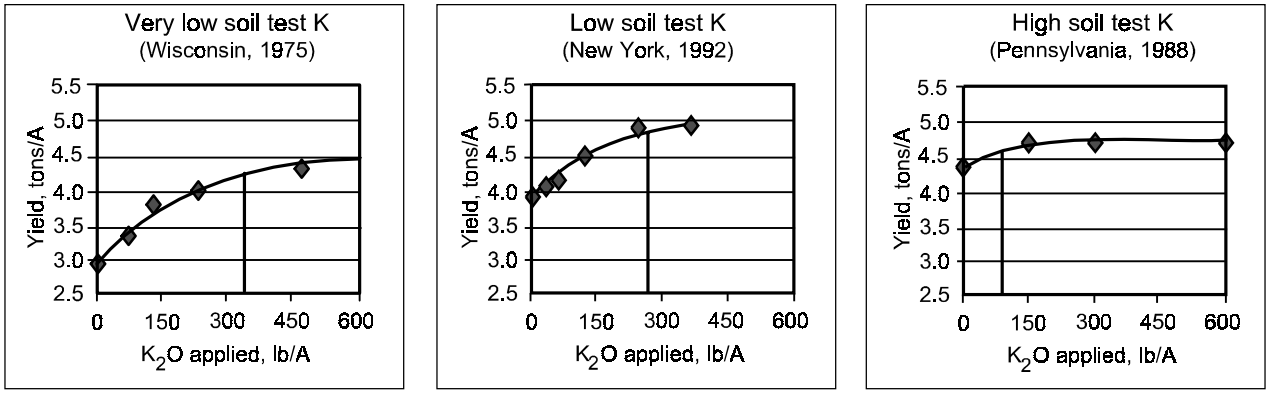

Figure 2. Examples of alfalfa yield response to K at sites differing in soil test K. Yields are annual totals averaged over three to four years. Vertical lines indicate the rate of applied K for maximum economic yield, assuming a hay price of $90 per ton and K_2O at 14 cents per pound.

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