U T A H

Alfalfa Responses to Potassium on Low-Testing Soils

By R.T. Koenig, J.V. Barnhill, and J.A. Gale

A potassium (K) study conducted over two years produced increased alfalfa yield responses of 1.0 to 3.2 tons/A at application rates as high as 600 lb K_2O/A. A single application of 600 lb K_2O/A reduced yield at two of three sites, while split applications of 600 K_2O/A did not reduce yield. Results show that alfalfa may respond to high rates of K fertilizer on low K-testing soils and that very high rates of K are necessary to increase available soil K to adequate levels on low K-testing soils. Rates of potassium chloride fertilizer (KCl, 0-0-60) exceeding 400 lb K_2O/A should be split-applied to prevent yield reductions.

Alfalfa is an important forage and cash crop for producers in Utah and other western states. In the mid-1950s, Utah State University fertilizer guides declared no crop K deficiencies existed due to the high native levels of K in Utah soils and high K concentrations in many irrigation waters. Alfalfa yields at that time averaged less than 2 tons/A. Today, many growers are achieving irrigated alfalfa yields in excess of 8 tons/A. Since 1960, the incidences of low K-testing soils and alfalfa K deficiency symptoms have increased. Also, K fertilizer recommendations have failed to maintain adequate soil test K levels in many areas, likely due to the high K demand of productive alfalfa.

The main objective of this research was to determine alfalfa yield and soil test responses to high rates of K and, ultimately, to develop better K management recommendations for low K-testing soils.

Field Studies

Experiments were conducted at one location in 1999 and three locations in 2000 (**Table 1**). At the Cache county location in 1999, K fertilizer (KCl) was applied at rates of 0, 200, 400, and 600 lb K_2O/A in early April to established alfalfa. An additional treatment of 200 lb K_2O/A in April followed by 200 lb K_2O/A applied after the first and second cuttings (total of 600 lb K_2O/A) was also included.

At the Cache, Weber, and Sevier county locations in 2000, K was applied at rates of 0, 100, 200, 400, and 600 lb K_2O/A in early April to established stands. A split application treatment of 300 lb K_2O/A applied in early April followed by 300 lb K_2O/A applied after the first cutting was also included at each of these sites. Each experiment was a randomized complete block design with three to four replications. Yield and soil test K were measured at each location.

Results

Among sites and years, K responses ranged from 1.0 to 3.2 tons/A above the unfertilized treatments (**Figure 1**). Some yield depression was experienced at the 600 lb K_2O/A single application rate at the Cache and Weber locations. The split application resulted in significantly higher yields at both locations than the single application (**Figure 1**). Considering the current price of K fertilizer ($0.14/lb K_2O) and value of alfalfa hay ($80 to 100/ton), an application of at least 400 lb K_2O/A would be economical.

Apparently, the single application of

KCl at 1,000 lb/A required to achieve the 600 lb K_2O/A rate caused a negative salt effect. Rates of KCl exceeding 400 lb K_2O/A should be split-applied to prevent yield reductions. Alternatively, applying high rates of a K fertilizer with a lower salt index such as potassium sulfate [K_2SO_4, 0-0-50-18 sulfur (S)] will likely prevent yield reductions.

Incidences of K deficiency in alfalfa and low K-testing soils have increased in some areas. Alfalfa has a high requirement for K, which is removed in harvest.

The response to K was linear at the Sevier location, with little indication of a salt effect. The linear response to K at Sevier and the response to the split application at the Weber location indicate that the alfalfa at these two locations may have responded to additional K above the high 600 lb K_2O/A rate.

The application of 600 lb K_2O/A brought the soil test K levels up to an average of only 120 parts per million (ppm) at two of these sites, well below the critical level of 150 ppm used in current Utah State University fertilizer recommendations (**Figure 2**). Soil test K increased 1 ppm for each 5 lb K_2O/A applied at the Cache location and 1 ppm for each 12.5 lb K_2O/A applied at the Sevier and Weber locations. At this rate of change and considering the initial soil test K values (**Table 1**), 775 to 950 lb K_2O/A would be needed to bring the Weber and Sevier soils up to 150 ppm soil test K.

Research in Utah at these and previously studied sites shows a clear relationship between soil test K and relative yield (**Figure 3**).

Optimum soil test K levels were at or near the 105 ppm currently used in alfalfa fertilizer recommendations.

TABLE 1. Selected soil properties for the surface 12-in. soil layer at research locations.

	Cache county	Weber county	Sevier county
Texture class	Silt loam	Silty clay loam	Clay loam
% clay	25	28	29
% CCE[1]	37	0	54
pH	7.8	6.7	8.1
Soil test K[2], ppm	72	88	73

[1]Calcium carbonate equivalent
[2]Sodium bicarbonate extractable

Summary

Alfalfa hay removes large quantities of K. In areas with a long history of high yielding alfalfa production, soil test K can be depleted to the point where relatively high

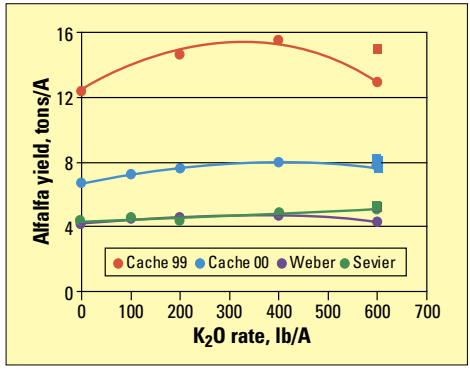

Figure 1. Effect of K fertilization on alfalfa yield at the Cache, Sevier, and Weber county locations.
(Circle symbols represent single application treatments, square symbols represent split application treatment).

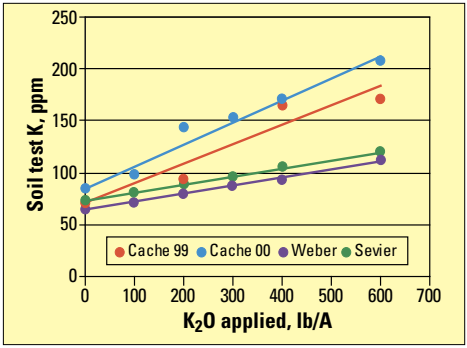

Figure 2. Effect of K fertilization on soil test K level at the Cache, Sevier, and Weber county locations.

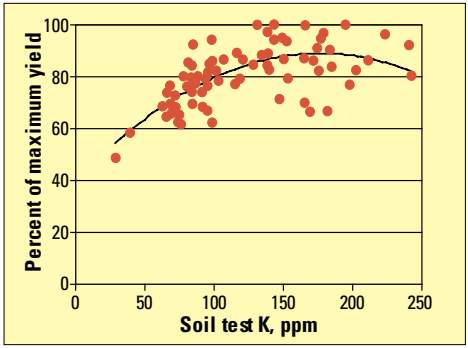

Figure 3. Relationship between soil test K (sodium bicarbonate extractable) and relative alfalfa yield.

rates of K are needed to rebuild soil tests.

Based on the results, the critical soil test K for alfalfa was not changed; however, K recommendations for very low and low soil test classes were increased by 50 to 100 lb K_2O/A. Increased emphasis is also being placed on annual soil testing for K and the importance of rebuilding and maintaining soil test levels in deficient areas. An electronic copy of the Utah State University fertilizer guide for alfalfa (AG-FG-01) can be found on the Internet at: http://extension.usu.edu/coop/ag/pub/index.htm. BC

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