NORTH DAKOTA– Fate of Potassium Fertilizer in Alfalfa in Soils with High Smectite/Illite Ratio

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Alfalfa is a heavy user of potassium (K), requiring 50-60 lbs/ac/ton DM and extracting over 300 lbs/K in a season. In K-deficient soils, the fertilizer (<150 ppm) part of the K applied to the soil is adsorbed into the clay minerals, especially in soils with high smectite/illite clay ratios. In this study, three alfalfa varieties (Presteez, Stratica, and LR-450) were fertilized with two K rates (150 and 300 lbs/ac of K_2O). Fertilizer was applied all at seeding or split (½ after 1st cut and ½ in September). Results indicate even at the highest K rate applied (300 lbs/ac), soil K levels did not increase compared with initial K levels in Milnor (smectite/illite). In the low smectite/illite ratio soil, in Lisbon, application of K increased soil K levels from initial levels (Table 1a).

Table 1a. Soil K variation with 0, 150, and 300 lbs/ac of K_2O and two sampling dates at two locations in 2019. Samples taken at 0-6" depth.

Location	Sampling Date	Harvest Date	0	150	150S	300	300S
			soil K level (ppm)				
Milnor	15 May	29 July	91.2a†	91.2a	96.5a	100.0a	90.2a
	8 Oct.	16 Oct.	74.2b	74.2b	81.6a	90.2a	90.8a
Mean			82.7B§	82.7B	89.0B	95.3AB	90.5B
Lisbon	10 May	30 July	76.3a	78.1a	78.8a	80.0b	78.9b
	9 Oct.	16 Oct.	63.9a	87.5a	86.0a	120.0a	127.8a
Mean			70.1B	70.1B	82.8B	82.5B	103.0A

Table 1b. Aboveground biomass K accumulation variation with five fertilizer treatments and two harvest dates at two locations in 2019.

Location	Sampling Date	Harvest Date	0	150	150S	300	300S
			Alfalfa Biomass K Accumulation (lbs/ac)				
Milnor	15 May	29 July	89.6a†	104.5a	92.7a	108.6a	91.2a
	8 Oct.	16 Oct.	48.8b	46.2b	47.3b	63.1b	58.8b
Sum			138.4B§	150.7B	140.0B	171.7A	150.0B
Lisbon	10 May	30 July	45.4a	56.6a	44.5a	53.1a	48.0a
	9 Oct.	16 Oct.	29.1b	32.6b	26.5b	32.3b	33.1b
Sum			74.5B	89.2A	71.0B	85.4A	81.1A

†For treatments, 0=0 lbs K_2O/ac; 150=150 lbs K_2O/ac applied at seeding, 150S=split-application: 75 lbs K_2O/ac applied at first cut, 75 lbs K_2O/ac applied in mid-Sept; 300=300 lbs K_2O/ac applied at seeding; 300S= split-application: 150 lbs K_2O ac applied at first cut, 150 lbs K_2O/ac applied in mid-Sept. §Milnor, high smectite:illite ratio (>3.5).

Alfalfa K uptake in the aboveground biomass was greater in Milnor than in Lisbon due to higher DM forage yield. However, even at the highest K rate application, uptake was not significantly different than the control with no K application at both locations, except for the 300 lbs/ac rate at Milnor (Table 1b). If soil test and K fertilization rates are summed up, K accumulation in the alfalfa biomass only explains about half of the K fate. As much as 300 lbs/ac of K applied as fertilizer is unaccounted for. Potassium fate is unknown, but we speculate K is being immobilized within the clay layers or being leached deep in the profile. Both sites have sandy loam soils. Analysis of the non-exchangeable K and available K at 4' deep is under investigation to determine how much of the K applied is being adsorbed by soil clays or leached deep in the soil profile.

In Summer 2020, right after the 2nd cut (July 2), alfalfa plants, regardless of variety, showed severe K deficiency symptoms in plots with no K application (Figure 1).

Figure 1. Alfalfa showing severe K deficiency. Picture taken in Lisbon, ND, July 2, 2020. Soil with <100 ppm soil K and no fertilizer application.

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