Silent Decline in Soil Potassium May Influence Sustainable Production of Alfalfa

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Introduction

- Alfalfa (*Medicago sativa* L.) is an important perennial forage crop:
  - Grows in the U.S. and many parts of the world;
  - Exported from hay farms to domestic livestock operations;
  - Exported to many countries around the world;
  - Value of the crop is in excess of $10 billion (USDA-NASS, 2014);
  - Fills an important rotational niche in the agricultural systems;
  - Fixes nitrogen (N) and supplies N to the following crops.
- Alfalfa production is heavily reliant on soil nutrients:
  - Continuous production results in depletion of soil nutrients (Lissbrant et al., 2009);
  - Potassium (K) is a key element and removed in high quantities with hay harvesting (Tarkalson and Shapiro, 2005);
  - Our knowledge on the effects of K application to soils with adequate residual amounts and soils with declining K is still rudimentary.
- Recent report suggests that median K levels have started to decline in many states of USA (IPNI, 2016):
  - K deficiency symptoms are commonly observed in alfalfa grown on Wyoming soils (Figure 1).
- Objective:
  - Determine the effects of K, cultivar, and harvest time on growth, yield, nutritive value, and stand persistence of alfalfa.

Figure 1. Sims' Ranch, Wyoming, USA: Top - alfalfa the year after seeding; white splotching on occasional leaflets (K deficiency symptom). Middle - closeup shows white spots ringing the leaflets, compared to normal leaflets. Bottom - shows progression of K deficiency symptoms.

Materials and Methods

- Study location:
  - University of Wyoming Sustainable Agriculture Research and Extension Center, near Lingle, Wyoming, USA (42°14'N, 104°30'W; 1272 m elevation).
- Study design:
  - Randomized complete block design with four replicates.
- Three factors:
  - Two alfalfa cultivars (HI-GEST 360, low lignin alfalfa; AFX 457, conventional alfalfa).
  - Four K rates (0 [control], 56, 112, and 168 kg K_2O ha^{-1}).
  - Two harvest dates (optimum growth stage [late bud to 10% bloom] and 7-10 days after the first harvest).
- Alfalfa seeding rate:
  - 22 kg pure live seeds ha^{-1}.
- Planting date:
  - September 8, 2016.
- Initial data collection:
  - Emergence, seedling count, and visual estimate of nutrient deficiency symptoms.
- Harvesting treatment will be in effect from spring 2017 and onwards.
- Data analysis:
  - ANOVA using Proc MIXED.

Results and Discussion

- The study is newly established and ongoing.
- Observation is being made and data is being collected continually.
- Initial observations suggest that the alfalfa stand is well-established (Figure 2)
  - Irrigation after seeding followed by some precipitations in September helped seeds to emerge and seedlings to establish.
- Treatments had no significant effect on early crop establishment (Table 1)
  - Average emergence was 55% and the values ranged from 35% (168 kg K_2O ha^{-1}; AFX 457; Late harvest) to 71% (168 kg K_2O ha^{-1}; HI-GEST 360; Late harvest).
  - Average seedling count was 254 seedlings m^{-2}.
  - The highest seedling count was 361 seedlings m^{-2} in plots receiving 56 kg K_2O ha^{-1} (AFX 457; Late harvest).
- The number of seedlings m^{-2} seemed to be enough for a successful alfalfa stand establishment (Islam, 2013).
- No visible nutrient deficiency symptoms were observed.

Conclusion

- Alfalfa stand was well-established with the influence of irrigation water and precipitations;
- No significant effect of K was observed among alfalfa cultivars;
- No nutrient deficiency symptoms were noticed in the young alfalfa seedlings;
  - These warrant continuous and long-term monitoring of the study.

Acknowledgment

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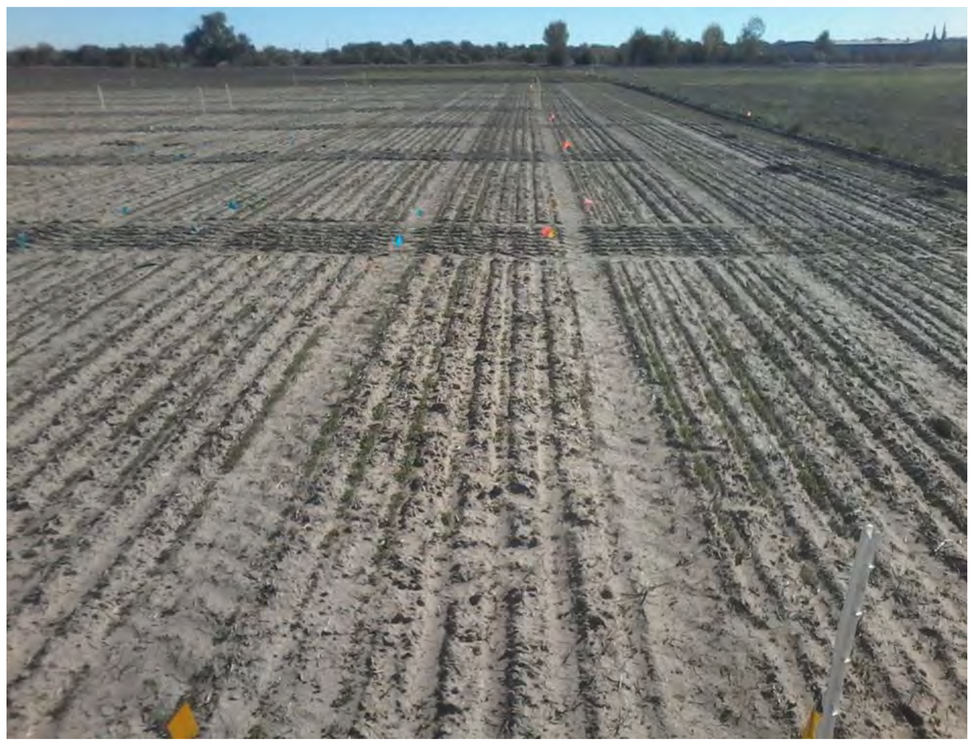

Figure 2. Alfalfa study plots at the University of Wyoming Sustainable Agriculture Research and Extension Center, near Lingle, Wyoming, USA. Picture was taken on October 8, 2016.

Table 1. Emergence and seedling counts for different combinations of alfalfa cultivar, K rate, and harvest date. Data was recorded on October 8, 2016.

Treatment description (K rate, kg K_2O ha^{-1}; cultivar; harvest date)	Emergence (%)	Number of seedlings (seedlings m^{-2})
0 (AFX 457; Early harvest)	55	228
56 (AFX 457; Early harvest)	48	170
112 (AFX 457; Early harvest)	56	225
168 (AFX 457; Early harvest)	55	242
0 (HI-GEST 360; Early harvest)	53	284
56 (HI-GEST 360; Early harvest)	53	314
112 (HI-GEST 360; Early harvest)	58	256
168 (HI-GEST 360; Early harvest)	58	228
0 (AFX 457; Late harvest)	51	270
56 (AFX 457; Late harvest)	58	361
112 (AFX 457; Late harvest)	58	250
168 (AFX 457; Late harvest)	35	183
0 (HI-GEST 360; Late harvest)	53	225
56 (HI-GEST 360; Late harvest)	60	342
112 (HI-GEST 360; Late harvest)	58	225
168 (HI-GEST 360; Late harvest)	71	261
Mean	55	254
P-value	0.75	0.87

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