Introduction

- Fertilization is an important agronomic practice for an efficient forage system.
- Potassium (K) requirement in alfalfa (Medicago sativa L.) is high.
- It absorbs K more than any other nutrients (Koenig, 2002).
- For optimum growth and development.
- Alfalfa’s productivity is greatly influenced by the uptake of K (Islam and Baidoo, 2019).
- Combining K with other agronomic factors is needed to optimize K uptake by alfalfa.
- For improving physiology and sustaining high production.
- Potential factors that could interact with K to enhance alfalfa’s K uptake includes:
  - Cultivar.
  - Harvest time.
  - Knowledge on the mechanism underlying K uptake by alfalfa as affected by cultivar, and harvest time is rudimentary.

Objective

- Determine the effect of K, cultivar, and harvest management on K uptake in alfalfa.

Materials and Methods

- The study was conducted at the Department of Plant Sciences, University of Wyoming, 1000 E. University Avenue, Laramie, WY 82071, USA.
- Treatments included:
  - 4 K rates: 0, 56, 112, and 168 kg K₂O ha⁻¹.
  - 2 Cultivars: “Hi-Gest 360” (highly digestible); “AFX 457” (conventional).
  - 2 Harvest times: early harvest (late bud to early [10%] bloom) (Figure 1); late harvest (7 days after early harvest).
- Potassium uptake was determined at each harvest:
  - Potassium (as muriate of potash) was applied annually, first at planting time.
  - Individual plot size: 2 m x 6 m.
  - Seeding rate: 22 kg pure live seed ha⁻¹.
- Potassium content in alfalfa was estimated using Near Infrared Reflectance Spectroscopy.
- Potassium uptake was determined at each harvest:
  - Potassium uptake = \( \frac{K}{\text{dry matter yield}} \).
- Data was analyzed using SAS 9.4.

Results and Discussion

- Cultivar did not affect (\( P > 0.05 \)) K uptake by alfalfa throughout the study period (Figure 2).
- This is attributed to the high yielding traits of both cultivars and their influence on K uptake abilities (Foth and Ellis, 1997; Islam and Baidoo, 2019).
- On average, annual total K uptake of AFX 457 (281 kg K ha⁻¹) was numerically higher than that of Hi-Gest 360 (272 kg K ha⁻¹).
- K rate × harvest time × year interaction had a significant effect (\( P < 0.05 \)) on K uptake by alfalfa.
  - Annual total K uptake was highest for 112 kg K₂O ha⁻¹ at late harvest, and for 168 kg K₂O ha⁻¹ at early harvest (Table 1).
- The dynamics of plant regrowth rate following time of harvest (Dhont et al., 2002) could explain this finding:
  - Compared to frequent late harvests, frequent early harvests result in less time for the build-up of root carbohydrate reserve; hence alfalfa takes up high K at early harvests to facilitate the activation of the numerous plant enzyme functions and accelerate the build-up of root carbohydrate reserve to improve its growth prior to the next harvest, and vice versa.

Table 1. Potassium uptake by alfalfa affected by potassium rate and harvest time at the University of Wyoming James C. Hageman Sustainable Agriculture Research and Extension Center from 2017 to 2019.

<table>
<thead>
<tr>
<th>Potassium (K₂O) rate</th>
<th>Potassium uptake (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2017</td>
</tr>
<tr>
<td>EH</td>
<td>LH</td>
</tr>
<tr>
<td>0</td>
<td>275( \bar{\bar{\bar{\text{a}}}} )</td>
</tr>
<tr>
<td>56</td>
<td>273b</td>
</tr>
<tr>
<td>112</td>
<td>279b</td>
</tr>
<tr>
<td>168</td>
<td>318a</td>
</tr>
<tr>
<td>Average</td>
<td>286</td>
</tr>
</tbody>
</table>

\( \bar{\bar{\bar{\text{a}}}} \)Potassium uptake; values were averaged over 4 harvests.

| EH; Early harvest (late bud to early [10%] bloom stage) |
| EH; Late harvest (7 days after early harvest) |

\( P < 0.05 \) = Means followed by same lowercase letters within each year are not significantly different.

- 3-year average total annual K uptake indicated that high K rates and moderate K rates at early and late harvest schedules, respectively, produced an optimum K uptake in alfalfa (Figure 3).
- There was a significant linear relationship (\( P = 0.026 \)) between alfalfa forage yield and K uptake (Figure 4).
- This suggests that the uptake of K by alfalfa is proportional to the productivity of alfalfa.

Summary and Conclusion

- Potassium and harvest time interaction affected K uptake by alfalfa.
  - Highest annual total K uptake was observed for:
    - 112 kg K₂O ha⁻¹ application rate at late harvest.
    - 168 kg K₂O ha⁻¹ application rate at early harvest.
  - Both cultivars had high K uptake.
  - Forage yield of alfalfa was associated with the K uptake.
  - Similar effect of K observed throughout the study period indicates that K uptake by alfalfa can be optimized with appropriate K rate along with harvesting schedule for sustaining high alfalfa productivity.

References


Acknowledgment

We thank Alforex Seed for providing seeds, University of Wyoming Forage Agronomy lab team and SAREC crew for assistance in the study. The study was funded by USDA-NIFA Alfalfa and Forage Research Program grant.