

**Minnesota Department of Agriculture
Pesticide & Fertilizer Management
AFREC QUARTERLY PROGRESS REPORTING
FOR THE PERIOD ENDING: MARCH 31, 2014**

PROJECT NUMBER: **R2013-F Q3. (AFREC contract 58566)**

PROJECT DESCRIPTION: **Potassium Fertilization Requirements for Intensively Managed Alfalfa Varieties**

REPORT DUE DATE: **4/1/2014**

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1.) GOALS AND OBJECTIVES OBTAINED

Goals accomplished: This report provides information for a project initiated in 2011. In 2013-2014, we have measured alfalfa stands in May and alfalfa yield at four locations to determine treatment effects. We have conducted educational activities to transfer results to producers. Although AFREC funding was terminated, we will continue to collect results in 2014.

Following completion of the study, we will use the results to influence the soil fertilization recommendations for alfalfa.

2.) ACTIVITIES PERFORMED AND OUTCOMES (*Describe the types of activities that you performed and the resulting outcomes...may include maps, photographs, etc.*)

Research was established at four locations: Goodhue (Lake City), Dakota (Rosemount), Sherburne (Becker), and Stearns (St. Martin) County. Three of the alfalfa experiments were established in 2011. Rosemount was established in 2012.

Experimental design: Randomized Complete Block with 4 replicates. Split-plot arrangement of treatments:
- Whole plot: K rates: 0, 60, 120, 240, 360 lbs K acre⁻¹ applied each spring
- Sub-plot: Alfalfa Varieties

Harvest dates in 2013 at each location were:

- Becker: 10 June, 10 July, 19 August, 15 October
- Lake City: 18 June, 11 July, 21 August, 18 October
- St. Martin: 10 June, 12 July, 23 August, 21 October
- Rosemount: 13 June, 15 July, 22 August, 14 October

We collected forage samples from alfalfas during harvesting for determination of tissue K content and forage quality at each harvest. We collected soil samples (0-6 inch) from all plots in October 2013 and these were sent to an analytical lab for analysis of pH and soil P, and K concentration.

Plant populations were measured in the spring at all locations. Populations and crown and roots were excavated in October to a 6 inch depth from three varieties at Becker and Lake City.

Results

Spring alfalfa populations: At Becker and Rosemount, spring plant population had a significant response to K application (Table 1; Figure 1); however, no response was observed at Lake City or Stearns. Plant population was significantly affected by variety at Lake City and Rosemount. At Lake City, 3979 and 54V46 had higher plant populations than the other varieties tested. At Rosemount, HYBRIFORCE-2400 had the highest plant population and FORAGEGOLD the lowest.

Forage yields: At all sites, except Stearns, total forage yield in 2013 had a significant response to K application (Table 2, Figure 2). At Becker and Rosemount, alfalfa forage yield increased with increasing K application until the 240 lbs K acre⁻¹ rate. At Lake City, all rates resulted in similar forage yield all of which were higher than the 0 K rate. Varieties differed in forage yield at each location although the relative ranking was inconsistent. Total (2012 and 2013) forage yield at each location reflected those observed in 2013 (Tables 3-6).

Fall alfalfa populations: In fall 2013, plant population and crown and root biomass were determined by manually removing plants at Becker and Lake City (Tables 7 and 8). At Becker, plant population and crowns, roots and total biomass (roots+crowns) had a significant response to K application. Although difficult to explain, plant population was highest for the 120 lbs K acre⁻¹. Crown and root biomass were similar for the 60 to 360 lbs K acre⁻¹ rates, but greater than the 0 K rate. Crown biomass was similar for 54V46 and FORAGEGOLD, but root and total (crown plus root) biomass was similar for the alfalfa varieties. At Lake City, crown biomass and total biomass were greatest at the 360 lbs K acre⁻¹. Plant population and root yields were greater for HYBRIFORCE-2400 and 56V46 than for FORAGEGOLD.

Soil K: Soil K concentration was affected by K fertilization rate at all sites (Tables 9-12, Fig. 3). At Stearns this response to K application was observed during Fall12 and Fall13 sampling but not at the Spring12 sampling.

Forage quality: Forage quality indicators such as crude protein, acid detergent fiber, neutral detergent fiber, and neutral detergent fiber digestibility were consistently affected by K fertilization at Becker, Lake City, and Rosemount (Tables 13-16). At Becker, Lake City and Rosemount, crude protein concentration was highest for the 0 K rate treatment but decreased as application rate increased. In contrast, at Becker and Lake City, acid detergent and neutral detergent fiber was lowest for the 0 K rate and increased as K rate increased. Forage K concentration consistently increased with increasing K application at all locations.

Educational activities

March 8, 2014. Preston, MN. Potassium fertilization requirements for intensively managed, modern alfalfa varieties. Craig Sheaffer.

March 26, 2014. Fergus Falls, MN. Potassium fertility with intensive managed alfalfa. Scott Wells.

March 27, 2014. St. Charles, MN. Potassium fertilization requirements for intensively managed, modern alfalfa varieties. Craig Sheaffer,

March 28, 2014. Kingston, MN. Potassium fertility with intensively managed alfalfa. Scott Wells.

Summary

Alfalfa is a perennial forage crop and we continue to investigate the long-term effects of K fertilization on alfalfa forage yield, forage quality, and stand density. Significant effects of K fertilization have been slow to develop, but we anticipate that additional years of measuring treatment effects will generate new information to inform fertilizer recommendations in the future. We will therefore be continuing to collect data in the years beyond the funding period.

Table 1. Plant population in spring of 2013 as affected by K fertilization and alfalfa varieties.

	Becker	Lake City	Rosemount	Stearns
K rateplants sqft ⁻¹			
0	16 b	12	16 a	15
60	18 ab	13	15 bc	13
120	19 a	13	14 c	15
240	19 a	13	16 ab	14
360	17 ab	14	15 ab	15
Varieties				
54V46	19	14 ab	16 abc	15
HYBRFORCE-2400	18	13 bc	17 a	15
FORAGEGOLD	18	13 bc	13 d	15
MAGNA 551	18	11 c	15 abc	14
55V48	19	13 bc	16 ab	15
PGI 557	20	12 c	14 cd	15
3979	17	14 a	16 abc	14
3980	17	12 bc	15 bcd	14
K rate (K)	**	NS	***	NS
Variety (V)	NS	***	***	NS
K vs V	NS	NS	NS	NS

*Significant at P value ≤ 0.10 ; ** Significant at P value ≤ 0.05 ; *** Significant at P value ≤ 0.01

Table 2. Total forage yield in 2013 as affected by K fertilization and alfalfa varieties.

	Becker	Lake City	Rosemount	Stearns [±]
K rateTon ac ⁻¹			
0	5.6 c	5.4 b	5.0 d	8.0
60	6.6 b	5.7 a	5.3 cd	8.0
120	7.0 ab	5.8 a	5.6 bc	7.7
240	7.4 a	5.9 a	6.5 a	7.9
360	7.3 ab	6.2 a	5.9 b	8.1
Varieties				
54V46	6.6 b	5.8 bc	5.6 bc	8.2 ab
HYBRFORCE-2400	6.7 b	6.1 a	5.7 ab	8.1 ab
FORAGEGOLD	6.5 b	5.8 bc	5.4 bc	8.0 b
MAGNA 551	7.0 ab	5.9 ab	5.7 ab	8.4 a
55V48	6.9 ab	5.7 bc	5.7 abc	8.0 b
PGI 557	7.0 ab	5.6 cd	5.4 c	8.1 ab
3979	7.4 a	6.0 a	5.9 a	7.5 c
3980	6.5 b	5.4 d	5.4 c	7.4 c
K rate (K)	***	***	***	NS
Variety (V)	**	***	***	***
K vs V	NS	NS	NS	NS

Table 3. Total forage yield for Becker. (2012 and 2013)

BECKER Total Forage Yield (Ton ac-1)			
K rate	2012	2013	Cumulative 12-13
0	5.8	5.6 c	11.4 c
60	5.4	6.6 b	12.0 bc
120	6.7	7.0 ab	13.7 a
240	6.5	7.4 a	13.9 a
360	6.0	7.3 ab	13.3 ab
Varieties			
3979	6.0 abc	7.4 a	13.4 a
3980	5.8 c	6.5 b	12.3 c
54V46	6.1 ab	6.6 b	12.7 abc
55V48	6.1 ab	6.9 ab	13.0 ab
FORAGEGOLD	5.8 bc	6.5 v	12.4 bc
HYBRFORCE-2400	6.1 ab	6.7 v	12.7 abc
MAGNA 551	6.2 a	7.0 ab	13.2 a
PGI 557	6.2 a	7.0 ab	13.2 a
K rate effect	NS	***	**
Variety effect	*	**	**

Table 4. Total forage yield for Lake City (2012 and 2013)

Lake City Total Forage Yield (Ton ac-1)			
K rate	2012	2013	Cumulative 12-13
0	7.1	5.4 b	12.5 b
60	7.7	5.7 a	13.3 a
120	7.6	5.8 a	13.4 a
240	7.8	5.9 a	13.6 a
360	7.5	6.2 a	13.7 a
Varieties			
3979	7.2 b	6.0 a	13.2 ab
3980	7.1 b	5.4 d	12.4 c
54V46	7.7 a	5.8 bc	13.4 ab
55V48	7.7 a	5.7 bc	13.4 ab
FORAGEGOLD	7.7 a	5.8 bc	13.4 ab
HYBRFORCE-2400	7.7 a	6.1 a	13.8 a
MAGNA 551	7.8 a	6.0 ab	13.7 a
PGI 557	7.4 ab	5.6 cd	13.0 b
K rate effect	NS	***	***
Variety effect	***	***	***

Table 5. Total forage yield for Rosemount. (2012 and 2013).

Rosemount12 Total Forage Yield (Ton ac-1)			
K rate	2012†	2013	Cumulative 12-13
0	2.3 b	5.0 d	7.3 d
60	2.5 ab	5.3 cd	7.7 cd
120	2.8 a	5.6 bc	8.3 bc
240	2.7 a	6.5 a	9.1 a
360	2.7 a	5.9 b	8.6 ab
Varieties			
3979	2.7 a	5.9 a	8.6 a
3980	2.7 a	5.4 c	8.1 bc
54V46	2.4 b	5.6 bc	8.0 c
55V48	2.5 ab	5.7 abc	8.2 bc
FORAGEGOLD	2.4 b	5.4 bc	7.9 c
HYBRFORCE-2400	2.7 a	5.7 ab	8.4 ab
MAGNA 551	2.6 a	5.7 ab	8.4 ab
PGI 557	2.7 a	5.4 c	8.1 bc
K rate effect	*	***	***
Variety effect	***	***	***

+ 2012 was the establishment year for Rosemount.

Table 6. Total forage yields for Stearns County. (2012 and 2013)

Stearns Total Forage Yield (Ton ac-1)			
K rate	2012	2013	Cumulative 12-13
0	5.7	8.0	13.4
60	5.4	8.0	13.4
120	5.9	7.7	13.5
240	5.8	7.9	13.7
360	5.7	8.1	13.8
Varieties			
3979	4.7 b	7.5 c	12.2 b
3980	4.5 b	7.4 c	11.9 b
54V46	5.9 a	8.2 ab	14.1 a
55V48	6.0 a	8.0 b	14.0 a
FORAGEGOLD	6.0 a	8.0 b	14.0 a
HYBRFORCE-2400	6.1 a	8.1 ab	14.1 a
MAGNA 551	6.1 a	8.4 a	14.5 a
PGI 557	6.2 a	8.1 ab	14.3 a
K rate effect	NS	NS	NS
Variety effect	***	***	***

Table 7. Fall alfalfa population, and root and crown yields at Becker as affected by K fertilization and alfalfa varieties. 2013

Becker – Fall 2013				
K rate	Plants	Crowns	Roots	Total (C+R)
	Plants sqft ⁻¹lbs ac ⁻¹		
0	14 b	15.9 b	2028 b	3621 b
60	14 b	1905 a	2595 a	4501 a
120	17 a	1999 a	3017 a	5017 a
240	13 b	1949 a	2784 a	4733 a
360	13 b	1922 a	3012 a	4934 a
Varieties				
54V46	16 a	1957 a	2792	4749
FORAGEGOLD	12 b	1988 a	2632	4619
HYBRFORCE-2400	14 ab	1677 b	26.38	4316
K rate effect	**	**	***	***
Variety effect	***	***	NS	NS
K x V	*	NS	NS	NS

*Significant at P value ≤0.10; ** Significant at P value ≤0.05; *** Significant at P value ≤0.01

Table 8. Fall alfalfa population, and root and crown yields at Lake City as affected by K fertilization and alfalfa varieties. 2013

Lake City– Fall 2013				
K rate	Plants	Crowns	Roots	Total (C+R)
	Plants sqft ⁻¹lbs ac ⁻¹		
0	8	2028 b	2220	4248 b
60	15	2305 ab	2326	4631 b
120	9	2066 b	2327	4393 b
240	9	1989 b	2285	4270 b
360	18	2524 a	2860	5383 a
Varieties				
54V46	18 a	2232	2541 a	4773
FORAGEGOLD	7 b	2199	2169 b	4368
HYBRFORCE-2400	11 ab	2116	2500 a	4614
K rate effect	NS	*	NS	*
Variety effect	*	NS	**	NS
K x V	NS	*	NS	NS

*Significant at P value ≤0.10; ** Significant at P value ≤0.05; *** Significant at P value ≤0.01

Table 9. Soil K concentrations at 0-6 inches at Becker as affected by K fertilization and alfalfa varieties

Becker – K soil concentrations			
	Spring-12	Fall-12	Fall-13
K ratemg K kg ⁻¹		
0	51.1 c	45.6 c	35.4 b
60	51.4 c	60.6 c	37.5 b
120	66.1 bc	70.8 bc	62.2 b
240	75.6 b	133.9 b	91.0 b
360	105.9 a	230.7 a	187.7 a
Varieties			
54V46	73.5	101.6	80.4
FORAGEGOLD	67.8	114.9	90.6
HYBRFORCE-2400	68.8	108.5	77.3
K rate effect	***	***	***
Variety effect	NS	NS	NS
K x V	NS	**	NS

*Significant at P value ≤0.10; ** Significant at P value ≤0.05; *** Significant at P value ≤0.01

Table 10. Soil K concentrations at 0-6 inches at Lake City as affected by K fertilization and alfalfa varieties.

Lake City – K soil concentrations			
	Spring-12	Fall-12	Fall-13
K ratemg K kg ⁻¹		
0	139.8 d	128.5 d	99.7 d
60	151.7 cd	140.1 cd	110.3 cd
120	163.4 bc	168.6 bc	131.6 c
240	175.8b	201.8 b	183.5 b
360	207.8 a	280.2 a	255.6 a
Varieties			
54V46	167.7	185.2 ab	150.6 b
FORAGEGOLD	166.7	193.1 a	169.3 a
HYBRFORCE-2400	168.7	173.2 b	148.6 b
K rate effect	***	***	***
Variety effect	NS	**	***
K x V	NS	*	**

Table 11. Soil K concentrations at 0-6 inches at Stearns as affected by K fertilization and alfalfa varieties.

Stearns– K soil concentrations			
	Spring-12	Fall-12	Fall-13
K ratemg K kg ⁻¹		
0	209.2	186.3 c	159.7 c
60	237.5	247.7 bc	185.6 bc
120	232.8	259.5 b	207.3 bc
240	232.3	296.2 b	267.5 b
360	273.7	434.9 a	415.8 a
Varieties			
54V46	234.8	274.6	245.3
FORAGEGOLD	245.0	304.4	245.9
HYBRFORCE-2400	231.5	275.8	250.4
K rate effect	NS	***	***
Variety effect	NS	NS	NS
K x V	NS	NS	NS

Table 12. Soil K concentrations at 0-6 inches at Rosemount as affected by K fertilization and alfalfa varieties.

Rosemount12– K soil concentrations		
	Fall-12	Fall-13
K ratemg K kg ⁻¹	
0	102.3 c	81.3 b
60	104.8 c	84.3 b
120	110.3 c	93.3 b
240	132.0 b	98.8 b
360	160.4 a	162.3 a
Varieties		
54V46	123.2	102.0
FORAGEGOLD	123.5	106.4
HYBRFORCE-2400	119.2	103.7
K rate effect	***	***
Variety effect	NS	NS
K x V	NS	NS

Table 13. Average forage quality at Becker in 2013- K rate and variety effect.

Treatment	CP	ADF	NDF	NDFD	LAB K
			-----%-----		
0	22.4 a	28.1 b	36.9 c	47.7 a	0.93 e
60	20.5 b	28.4 b	37.5 bc	43.7 b	1.41 d
120	21.1 ab	29.5 ab	38.9 ab	45.2 ab	1.89 c
240	20.6 b	30.4 a	40.3 a	44.4 ab	2.36 b
360	20.0 b	30.4 a	40.3 a	42.4 b	2.64 a
54V46	20.9	29.9	39.4	45.5	1.80
FORAGEGOLD	21.0	29.2	38.6	44.4	1.83
HYBRFORCE-2400	20.9	29.1	38.3	44.1	1.91
P values					
K rate (K)	**	***	***	**	***
Variety (V)	NS	NS	NS	NS	NS
K x V	**	NS	NS	*	NS

*Significant at P value ≤ 0.10 ; ** Significant at P value ≤ 0.05 ; *** Significant at P value ≤ 0.01

†Forage quality is averaged for four harvests.

Table 14. Average forage quality at Lake City in 2013. K rate and variety effect.

Treatment	CP	ADF	NDF	NDFD	LAB K
			-----%-----		
0	21.9 a	26.3 c	34.3 c	48.0	1.82 e
60	21.7 ab	26.7 bc	35.2 bc	46.8	2.12 d
120	21.3 abc	27.4 abc	36.3 ab	46.2	2.43 c
240	20.8 c	28.3 a	37.7 a	46.1	2.71 b
360	20.9 bc	27.7 ab	37.1 a	45.4	2.91 a
54V46	21.2	27.7	36.7 a	47.0	2.36 b
FORAGEGOLD	21.3	26.9	35.7 b	46.6	2.36 b
HYBRFORCE-2400	21.5	27.2	36.0 ab	45.9	2.47 a
K rate (K)	**	NS	***	NS	***
Variety (V)	NS	NS	*	NS	*
K x V	NS	NS	NS	NS	NS

*Significant at P value ≤ 0.10 ; ** Significant at P value ≤ 0.05 ; *** Significant at P value ≤ 0.01

† Forage quality is averaged for four harvests.

Table 15. Average forage quality in Stearns County in 2013. K rate and variety effect.

Treatment	CP	ADF	NDF	NDFD	LAB K
			-----%-----		
0	21.8	26.7	36.3 b	46.6	2.17 d
60	21.6	26.6	35.7 b	46.7	2.50 c
120	21.3	27.0	36.1 a	45.3	2.53 bc
240	21.5	26.5	35.5 b	45.0	2.75 b
360	21.0	27.4	37.0 a	45.3	3.00 a
54V46	21.2 b	27.2 a	36.4 a	46.3 a	2.54
FORAGEGOLD	21.7 a	26.5 b	35.4 b	45.8 ab	2.58
HYBRFORCE-2400	21.5 ab	26.8 ab	35.9 ab	45.2 b	2.64
K rate (K)	NS	NS	*	NS	***
Variety (V)	**	*	*	**	NS
K x V	NS	NS	NS	NS	NS

*Significant at P value ≤ 0.10 ; ** Significant at P value ≤ 0.05 ; *** Significant at P value ≤ 0.01

† Forage quality is averaged for four harvests.

Table 16. Average forage quality at Rosemount in 2013. K rate and variety effect

Treatment	CP	ADF	NDF	NDFD	LAB K
			-----%-----		
0	22.3 A	27.2 b	35.7 c	51.0 a	0.99 c
60	21.8 A	27.3 b	36.1 bc	50.1 ab	1.18 c
240	20.8 B	28.4 a	37.9 a	48.4 c	1.98 b
360	20.6 B	27.6 b	37.1 ab	48.6 bc	2.27 a
54V46	21.5	27.7 ab	36.8 ab	50.3 a	1.62
FORAGEGOLD	21.6	24.0 b	35.9 b	49.6 ab	1.63
HYBRFORCE-2400	21.1	28.1 a	37.4 a	48.8 b	1.56
K rate (K)	***	*	***	**	***
Variety (V)	NS	**	**	**	NS
K x V	NS	NS	NS	NS	NS

*Significant at P value ≤ 0.10 ; ** Significant at P value ≤ 0.05 ; *** Significant at P value ≤ 0.01

†. Forage quality is averaged for four harvests.

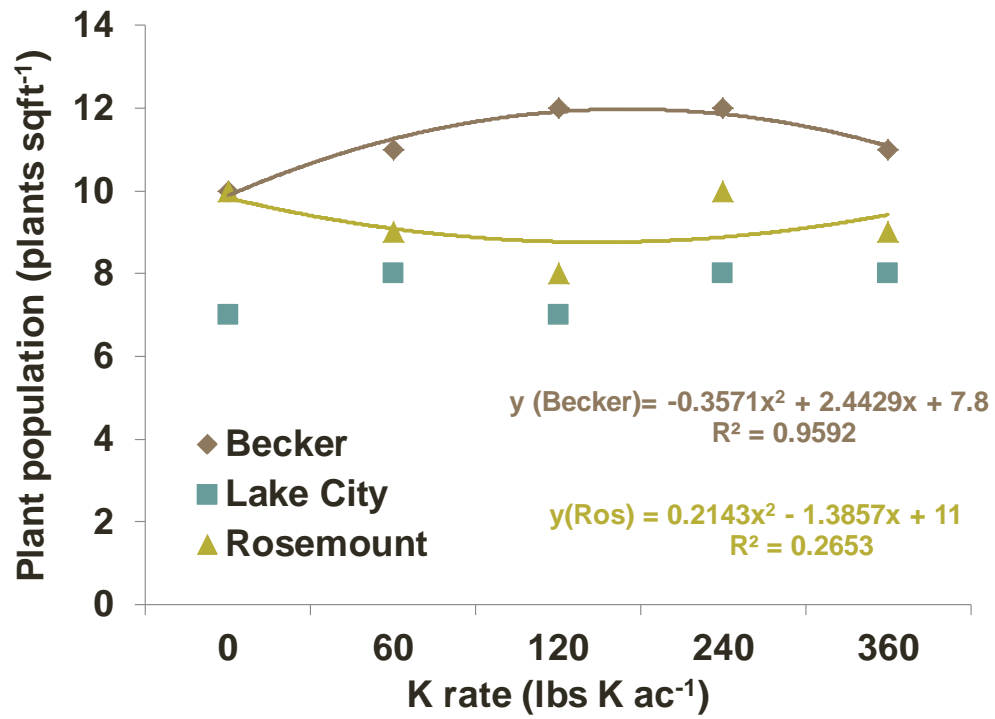


Figure 1. Plant population response to K application in spring 2013

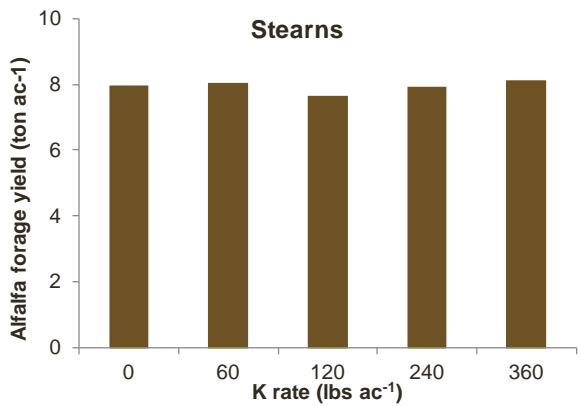
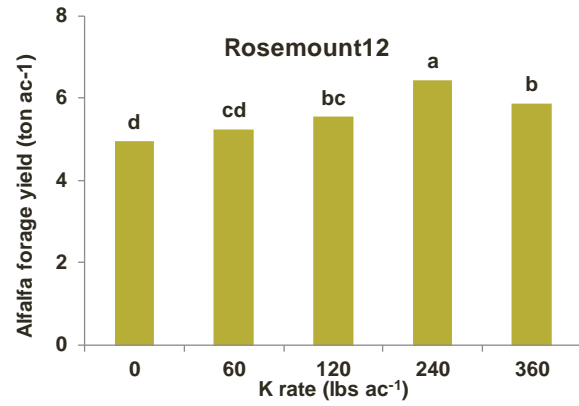
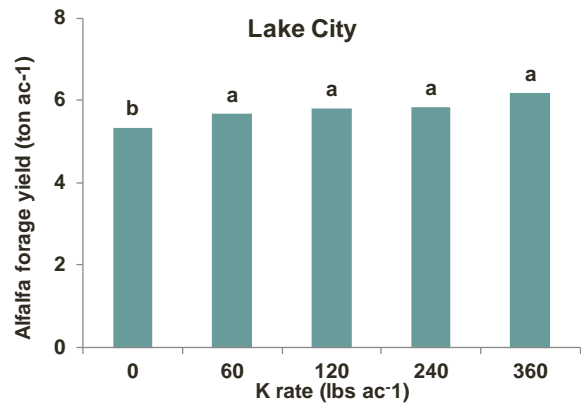
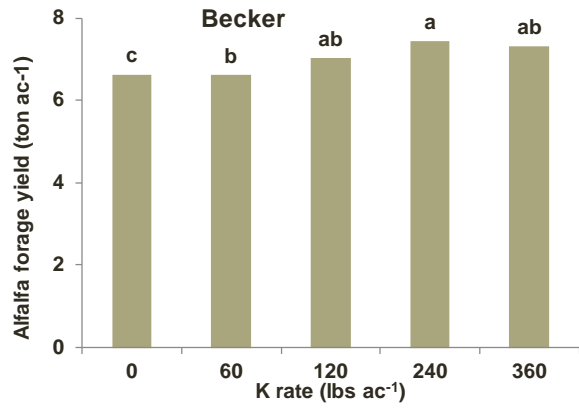


Figure 2. Total forage yield 2013- K fertilizer rates effect.

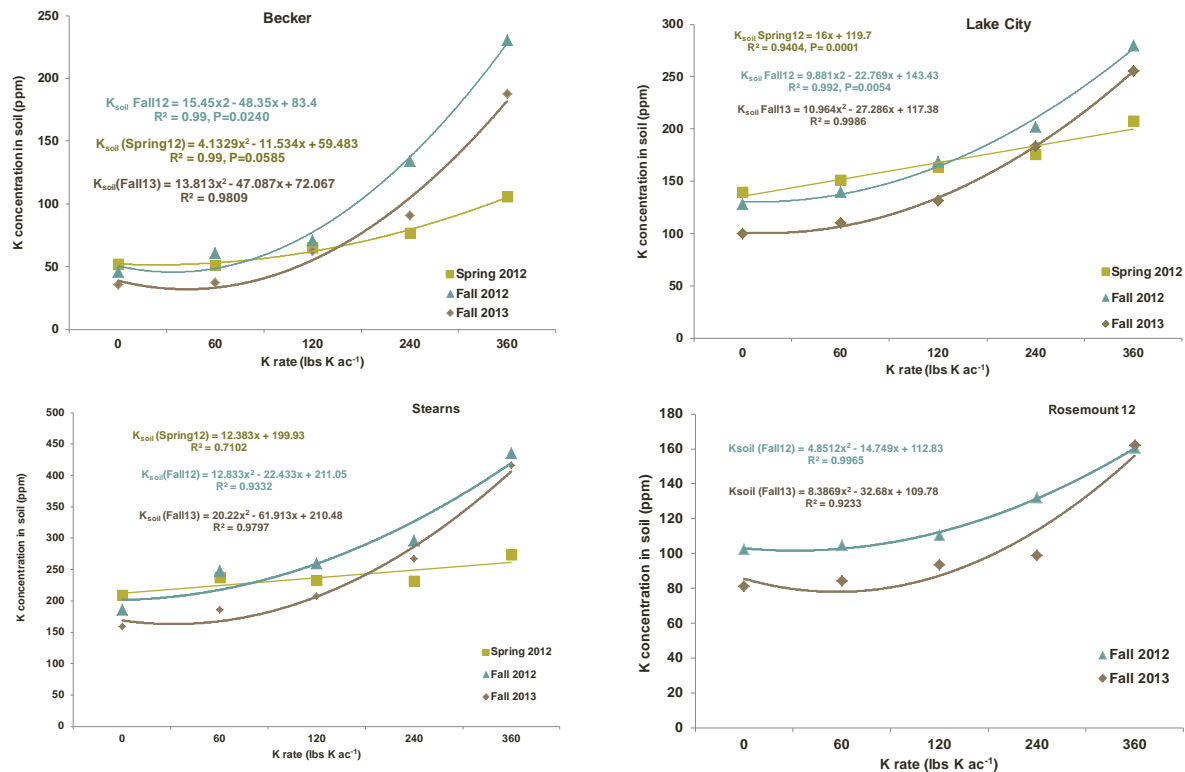


Figure 3. Soil K concentration at 0-6 inches for different sampling times at all locations in response to K fertilization.

3.) CHALLENGES ENCOUNTERED AND LESSONS LEARNED (*Describe any challenges that you encountered and what was learned from those challenges.*)

Challenges: None

4.) FINANCIAL INFORMATION (*This may include balance sheets or general ledger. The reports should be broken out by budget category as listed in the grant agreement and should show how much grant funding and how much match funding was spent. No more than 10% of the total award can moved from one budget category to another without prior approval. Provide analysis, explanations, and specific reasons why any cost overruns may have occurred. Attach sheets as necessary to provide this information.*)

To be provided by the University of Minnesota.