1998 Response of Established Perennial Forages to Nitrogen, Phosphorus, Potassium and Sulfur

Project Personnel

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Objectives

1. To evaluate the response of dryland alfalfa and alfalfa/grass mixtures to broadcast nitrogen, phosphorus, potassium and sulfur in central Montana.

2. To evaluate sulfur formulation effect on alfalfa yield response to sulfur application.

Methods

Study 1

N, P, K and S were applied to alfalfa/grass stand near Geyser in 1993 and 1994. The fertilizer was applied one time. Rates evaluated were N @ 50lbs/a, P @ 50, 100, & 200 lbs/a, K @ 50 lbs/a, and S @ 25 lbs/a. P was applied both banded and broadcast in an additional study. Spring of 1997 N, P, K and S were broadcast applied to irrigated alfalfa near Eddies Corner in demonstration plots. Yields samples were machine harvested and heat dried.

Study 2

Three sulfur formulations were applied to dryland alfalfa at CARC in April 1996 in two different fields (SW2 and SW3). The sulfur was broadcast applied at a rate of 24 lbs S per acre. All plots received 22 lbs/a N to balance N rates with the ammonium sulfate N. Yields samples were machine harvested and heat dried.

Results and Discussion

Study 1

Phosphorus rate had a greater effect on alfalfa/grass yield in the fifth harvest season and on total yield over the five harvest seasons at Geyser (Table 1). Increasing P by 0, 50, 100, and 200 lbs/a acre resulted in 1998 yields of 0.56, 0.71, 0.96, and 0.98 t/a dry matter, respectively. N, K and S did not effect 1998 yield or the five season total yield. Quality is sometimes reduced as yield increases or may not be affected at all as it was here (Tables 2

& 3). Banding P had a slight advantage on broadcast P over five seasons (Table 3). Demonstration strips near Eddies Corner exhibited 0.5, 0.6, & 0.89 t/a yield response to a 1997 application of 50, 100, and 200 lbs/a P, respectively (Table 4). The first replication received more irrigation water than the second replication, thus yielding more.

Study 2

Ammonium sulfate and pearled sulfur fertilizer, both containing 24 lbs S/a, were applied in the spring of 1996. Dry matter yields in 1998 were increased 0.46 and 0.53 t/a, respectively (Table 5). Over three harvest years the ammonium sulfate and pearled sulfur increased production 1.0 and 0.35 t/a, respectively. The sulfur did not affect quality significantly (Table 6).

Yield samples were harvested from the ammonium sulfate strips. Finding the strips was easy due to visual differences between strips having ammonium sulfate applied versus strips having pearled sulfur applied. Yields in field SW2 with and without sulfur were 1.5 t/a and 0.5 t/a, respectively. Second cutting yields in field SW3 with and without sulfur were 0.45 t/a and 0.18 t/a, respectively. Sulfur content in the plant tissue in field SW2 with and without sulfur were 0.25% and 0.13%, respectively and sulfur content in in the second cutting from field SW3 with and without sulfur were 0.28% and 0.14%, respectively.

- ## Summary

At $60.00/t hay a 0.15 t/a yield response has a gross value of $ 9.00 per acre which is 72% of the $12.50 original cost of 50 lbs/a P fertilizer and application cost. Over a five year period, the gross return @ 60/t hay has been $111, $140.40, and $172.20 per acre for gross P cost of $12.50, $25.00 and $37.50. Keep in mind there was a base amount of 50 lbs N, 50 lbs K, and 25 lbs sulfur applied to each P rate. However, data show these three elements had little to no effect on the yield. Plant tissue samples have not been analyzed for S content.

Ammonium sulfate provided the only significant yield response to sulfur in the first two seasons. It appears the pearled sulfur is now becoming available to the alfalfa because it produced significantly more forage than the untreated check.

- ## Future Plans

Demonstration strips may be established in the Geyser area meadow where the fertilizer trial was established to provide a more visual assessment for producers.

Field plots have been established in field SW2 at the Central Agricultural Research Center to compare banding vs broadcasting of the three sulfur formulation. Multiple sulfur rates will be tested, also. In addition, an off-station location will be sought for the banded S evaluation.

Table 1. 1998 and five-year alfalfa yield response to 1994 broadcast fertilizer application near Geyser, MT.

Trt #	Fertilizer N	P	K	S	Sulfur[1]	- - - - - - Dry Matter - - - - - - 1998	5 yr. Total
						- - - - - - - tons/ac - - - - - -	
1	50	200	50	25	ds	0.98	7.10
6	50	100	50	25	ds	0.96	6.77
5	50	100	50	25	es	0.93	6.57
3	50	50	50	25	ds	0.71	6.08
2	50	0	50	25	ds	0.56	4.23
4	0	0	0	0		0.66	4.08
7	0	100	50	25	ds	0.90	6.83
8	50	100	0	0		0.89	6.80
9	50	100	50	0		0.87	6.48
Mean						**0.83**	
F- trts (df=16)						4.76	
CV (S/MN) %						14.22	
LSD(0.05 by t)						0.20	

1/ ds - dissolving/livestock sulfur (90%)
es - elemental sulfur(99.9%)
Fertilized: 3/18/94; **Harvested**: 7/20/98

Table 2. 1998 Alfalfa quality response to broadcast fertilizer application near Geyser, Montana.

Trt #	Fertilizer N	P	K	S	Sulfur Source	- - - - - - Dry Matter - - - - - - CP %	ADF %	NDF %	RFV (value)
1	50	200	50	25	ds	17.13	30.47	36.33	167.1
6	50	100	50	25	ds	16.67	30.60	35.33	171.8
5	50	100	50	25	es	17.03	30.17	34.97	174.3
3	50	50	50	25	ds	16.63	30.03	34.57	176.3
2	50	0	50	25	ds	16.50	28.70	34.33	179.3
4	0	0	0	0		15.77	30.17	35.07	173.7
7	0	100	50	25	ds	16.73	30.90	35.80	168.9
8	50	100	0	0		16.80	31.70	36.77	163.3
9	50	100	50	0		16.93	31.20	36.37	166.1
Mean						**16.69**	**30.44**	**35.50**	**171.2**
F- trt (df=16)						0.50	0.49	0.65	0.53
CV (S/Mean) %						5.89	6.86	5.19	7.27
LSD (0.05 by t)						1.70	3.62	3.19	21.55

Table 3. 1998 and five-year alfalfa yield response to phosphorus fertilizer application method and rate near Geyser, MT.

Method	Phosphorus	1998	5 Yr. Total	CP	ADF	NDF	RFV
		----------Dry Matter----------					
	lbs/a	--------T/a--------		%	%	%	(value)
Banded	**200**	0.96	6.78	16.45	31.08	42.53	142.2
Broadcast	**200**	0.90	6.42	16.00	31.02	42.35	143.0
Banded	**50**	0.81	6.17	17.15	29.10	38.58	160.1
Broadcast	**50**	0.72	5.73	16.70	29.53	40.88	150.3
Banded	**0**	0.56	4.24	17.08	28.25	37.05	168.1
Broadcast	**0**	0.55	4.27	16.47	29.78	40.90	150.4
Mean		**0.75**		**16.64**	**29.79**	**40.38**	**152.3**
CV (S/Mean)%		21.02		6.35	4.67	6.74	7.94
LSD (0.05)		0.24		ns	2.10	4.10	18.22

Fertilized: 3/18/94; Harvested: 7/20/98

Table 4. 1998 Irrigated alfalfa yield response to fertilizer near Eddies Corner. Demo. July 8 and August 8 harvests. Central Agricultural Research Center, Moccasin, MT.

Trt #	---------Fertilizer---------				----------Dry Matter Yield ---------- Rep 1	Rep 2	Mean	Rep1-Rep2[1/]	97 Sulfur Content
	N	P	K	S	t/a	t/a	t/a	t/a	%
1	22	100	25	0	4.695	2.655	3.675	2.040	22.4
2	22	100	0	24	5.129	3.095	4.112	2.034	26.9
3	22	0	25	24	3.944	2.668	3.306	1.276	26.6
4	0	100	25	24	5.016	3.013	4.014	2.003	25.9
5	0	0	0	0	3.378	2.318	2.848	1.060	25.7
6	22	50	25	24	4.685	2.940	3.812	1.745	24.7
7	22	100	25	24	4.730	3.073	3.901	1.657	19.1
8	22	200	25	24	5.273	3.115	4.194	2.158	21.5
9	0	100	50	0	5.024	3.273	4.148	1.751	25.6
Mean					**4.653**	**2.905**	**3.779**	**1.748**	

Trt #	-------Fertilizer-------				CP	NDF	ADF	TDN	RFV
	N	P	K	S	%	%	%	%	(value)
1	22	100	25	0	17.8	32.8	43.4	63.6	136
2	22	100	0	24	20.8	28.6	36.6	68.0	169

3	22	0	25	24	18.5	29.6	37.9	67.0	162
4	0	100	25	24	18.7	30.7	38.5	65.8	157
5	0	0	0	0	17.3	32.3	41.4	64.2	143
6	22	50	25	24	18.5	29.2	37.5	67.5	164
7	22	100	25	24	17.1	32.6	43.4	63.8	136
8	22	200	25	24	16.3	36.6	47.1	59.5	119
9	0	100	50	0	18.6	31.4	41.1	65.1	146
Mean					**18.18**	**31.53**	**40.78**	**64.9**	**148**

1/ Rep 1 received more irrigation water than Rep 2. This column shows the difference in yield between the two replications.