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Fertilizer Affects on Irrigated Cool Season Grass Hay Yields & Quality at Ray Daly's

Hay from cool season perennial forage grasses harvested in the boot to seed-head emergence stage can provide an adequate amount of protein and energy to livestock, especially dry beef cows and sheep ewes. Nitrogen fertilizer generally will increase grass crude protein content. The increase can be enough to meet the crude protein needs of a lactating beef cow or sheep ewe.

Many range livestock producers calve and lamb in late winter/early spring prior to grass green up and thus need to provide their livestock high quality hay. Alfalfa hay is often fed to livestock during this period as it contains an adequate amount of crude protein and energy but if grass hay can meet livestock nutritional needs it would provide producers with added flexibility in the management of their operations.

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Hay from cool season grasses and alfalfa grown in northeast Wyoming often does not contain adequate amounts of phosphorus, manganese, or zinc to meet the needs of cattle and sheep. Fertilizing grass hay fields with these minerals may increase their content in the hay reducing or possibly eliminating the need to provide these minerals to livestock in a feed supplement.

Project objectives were to determine the affect nitrogen, phosphorus, manganese, and zinc fertilizers had on cool season grass hay yield and quality.

In 2005 and 2006 fertilizers were applied to Manska pubescent wheatgrass (PWG), Oahe intermediate wheatgrass (IWG), NewHy hybrid wheatgrass (HWG), Critana thickspike wheatgrass (TWG), and Regar meadow bromegrass (MBG). Fertilizers applied were: None (Control); nitrogen (N); phosphorus (P); N + P; N + P + manganese (Mn); N + P + zinc (Zn); and N + P + Mn + Zn. Fertilizers rates were: 100 lb N/ac; 50 lb P/ac; 4 lb Mn/ac; and 5 lb Zn/ac. In 2006 P was not applied. In 2005 N and P were applied on 18 April and Mn and Zn on 20 May. In 2006 N was applied on 19 May and Mn and Zn on 15 May. There were three replications of each fertilizer treatment.

April and May precipitation in 2005 was sufficient to forego irrigation prior to hay harvest, but in 2006 it was lacking and irrigation water was applied in early June.

Grass growth from each fertilizer treatment was harvested to a two-inch stubble height on 22 June 2005 and 2006 to determine hay yield. Forage from each grass by fertilizer treatment underwent quality analysis.

Soil samples were collected from the field on 18 April 2005 prior to application of fertilizer and on 29 September 2005 and 13 October 2006 from each fertilizer treatment and analyzed for nitrate-N, P, Mn, and Zn.

Forage quality and soil analyses were performed by the University of Nebraska Soil and Plant Analytical Lab and funded by the Wyoming Private Grazing Lands Team.

Nitrogen fertilizer increased grass hay yields by an average of 2110 and 1270 lb/ac in 2005 and 2006, respectively (Table 1). The smaller increase in 2006 was probably due to N fertilizer being applied a month later and the lack of April and May precipitation. The dry spring of 2006 resulted in grass hay

yields averaging 1835 lb/ac less in the Control and P treatments, and 2735 lb/ac less in the N+ treatments compared to 2005.

For the two years 100 lb N/ac resulted in an average increase in hay yield of 1630, 3210, 1700, 1080, and 830 lb/ac for Manska PWG, Oahe IWG, NewHy HWG, Critana TWG, and Regar MBG, respectively (Table 1). Critana TWG produced an average of 2200 lb/ac less hay compared to the other grasses.

In 2005 and 2006 nitrogen fertilizer at 100 lb N/ac cost \$35 and \$41, respectively, and hay brought \$80 and \$100/T. With a \$4/ac application cost the per acre increase in income in 2005 for Manska PWG, Oahe IWG, NewHy HWG, and Critana TWG would have been \$45, \$140, \$58, and \$9, respectively, with a \$24/ac loss for Regar MBG. In 2006, per acre increase in income for these grasses would have been \$13, \$53, \$4, \$3, and \$19, respectively.

Phosphorus, manganese, and zinc fertilizers did not appear to increase grass hay yields and thus profits would be reduced if cost of these fertilizers was included. However, determining what effect these fertilizers had on grass P, Mn, and Zn contents was the main purpose for applying them and will be discussed below.

Net Energy maintenance content of the grasses among fertilizer treatments was similar (Table 2) and, except for Regar MBG in 2005, was sufficient to meet the needs of a lactating beef cow (0.60 Mcal/lb) or sheep ewe (0.60 – 0.62 Mcal/lb).

Nitrogen fertilizer increased grass crude protein content by an average of 2% (Table 3). As a result the grasses contained an adequate amount of crude protein to meet the needs of a lactating beef cow and a late gestating sheep ewe (10.7%).

The field's soil contained 2.9 ppm nitrate-N on 18 April 2005. On 29 September 2005 and 13 October 2006 soil from the control and P treatments contained 1.7 and 4.8 ppm nitrate-N, respectively, whereas, soil from the N+ treatments contained an average of 1.4 and 4.1 ppm nitrate-N, respectively.

Phosphorus fertilizer did not increase grass P content (Table 4). P content among the grasses was similar and adequate for a lactating beef cow (0.21%) and a sheep ewe in her first 15 weeks of gestation (0.20%).

On 18 April 2005 field soil P content was 32 ppm. Soil P content on 29 September 2005 and 13 October 2006 was similar among the fertilizer treatments averaging 26 and 12 ppm, respectively.

Fertilizer treatments did not appear to affect levels of calcium (Ca), potassium (K), magnesium (Mg), sulfur (S), iron (Fe), or copper (Cu) found in the grasses (Tables 5 - 10). The grasses contained an average of 0.63% more K in 2005 compared to in 2006 but they contained more Ca (0.14%), S (0.04%), Mg (0.04%), Fe (13 ppm), and Cu (0.7 ppm) in 2006 compared to in 2005.

Calcium content of the grasses was adequate to meet the needs of a lactating beef cow (0.31%) or sheep ewe (0.32 – 0.39%), especially if she was not suckling twins.

The grasses contained more than enough K to meet the needs of a lactating beef cow (0.70%) and sheep ewe (0.70 – 0.80%).

Grass Mg content was adequate in 2006 to meet the needs of a lactating sheep ewe (0.18%) with Regar MBG containing enough for a lactating beef cow (0.20%). However, except for Regar MBG, the grasses did not contain enough Mg in 2005 to meet the needs of a lactating sheep ewe.

Sulfur content of the grasses was sufficient for a beef cow in all production stages (0.15%) and a sheep ewe, except for Regar MBG in 2005 that did not contain enough for a lactating ewe (0.18%).

The grasses contained enough Fe to meet the needs of a beef cow (50 ppm) and sheep ewe (30 ppm) but not enough Cu (10 ppm), except for Oahe IWG and Manska PWG that contained an adequate amount for a ewe in lactation (8 ppm).

Manganese and Zinc fertilizers did not increase grass Mn or Zn contents in 2005 (Tables 11 and 12) but in 2006 Critana TWG and Regar MBG from the Mn treatments contained an average of 29 ppm more Mn. In addition, grass Zn content from the Zn treatments increased by an average of 25 ppm with that for Critana TWG and Regar MBG by 44 ppm which resulted in these two grasses containing an adequate amount of zinc to meet the needs of a beef cow (30 ppm) and sheep ewe (33 ppm). The grasses appeared to contain more Mn or Zn from the Mn and Zn only treatments compared to Mn + Zn treatment. Why there was an apparent reduction in plant uptake of Mn or Zn when these two fertilizers were applied together is not known.

The grasses contained an adequate amount of Mn to meet the needs of a sheep ewe (20 ppm) and a beef cow (40 ppm), except for NewHy HWG both years and Critana TWG in 2005 (Table 11).

Soil Mn and Zn contents on 18 April 2005 were 25.5 and 1.4 ppm, respectively. Fall 2005 and 2006 soil Mn content from the Mn and non-Mn fertilizer treatments averaged 15.4 and 12.9 ppm, respectively, and soil Zn content from the Zn and non-Zn fertilizer treatments averaged 2.2 and 0.9 ppm, respectively.

Table 1: Fertilized grass hay yields (lb/ac) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	5670	8540	4090	7210	7570	8320	7250	6950ab ²
Oahe IWG	3860	8860	6930	7100	8190	8430	9000	7480a
NewHy HWG	4540	6280	5010	7120	6950	7610	6880	6340 b
Critana TWG	4430	5200	3460	6210	5660	5080	5980	5150 c
Regar MBG	7360	8320	7340	7410	7920	7880	7140	7620a
Average	5170b ³	7440a	5370b	7010a	7260a	7460a	7250a	
2006:								
Manska PWG	3730	4750	3650	4770	5220	4910	4780	4540 bc
Oahe IWG	3570	5280	4730	6110	4670	6110	5480	5130a
NewHy HWG	4380	5450	3730	5690	5050	5060	5530	4980ab
Critana TWG	1530	2840	1920	2420	2780	2110	2310	2270 d
Regar MBG	3200	4380	3900	4340	4900	4080	4710	4220 c
Average	3280b	4540a	3590b	4660a	4520a	4450a	4560a	

Table 2: Fertilized grass net energy maintenance contents (Mcal/lb) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	0.56	0.64	0.62	0.56	0.61	0.63	0.63	0.61a ²
Oahe IWG	0.60	0.63	0.60	0.58	0.62	0.61	0.62	0.61a
NewHy HWG	0.62	0.61	0.63	0.61	0.64	0.62	0.62	0.62a
Critana TWG	0.61	0.63	0.58	0.60	0.64	0.65	0.65	0.62a
Regar MBG	0.53	0.56	0.54	0.58	0.60	0.59	0.60	0.57 b
Average	0.58c ³	0.61ab	0.59bc	0.59bc	0.62a	0.62a	0.63a	
2006:								
Manska PWG	0.65	0.63	0.62	0.62	0.63	0.66	0.64	0.64a
Oahe IWG	0.61	0.60	0.59	0.61	0.60	0.59	0.60	0.60 b
NewHy HWG	0.60	0.60	0.63	0.61	0.63	0.62	0.62	0.61 b
Critana TWG	0.59	0.61	0.58	0.61	0.60	0.65	0.61	0.61 b
Regar MBG	0.64	0.65	0.61	0.63	0.64	0.64	0.65	0.64a
Average	0.62ab	0.62ab	0.61b	0.62ab	0.62ab	0.63a	0.63a	

¹PWG – pubescent wheatgrass; IWG – intermediate wheatgrass; HWG – hybrid wheatgrass; TWG – thickspike wheatgrass; MBG – meadow brome grass

²Grass averages within a year not connected by the same letter are significantly different at the 0.05 level of probability.

³Fertilizer treatment averages within a year not connected by the same letter are significantly different at the 0.05 level of probability.

Table 3: Fertilized grass crude protein contents (%) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	8.0	9.6	9.2	10.3	9.8	8.8	11.0	9.5 c ²
Oahe IWG	9.3	9.6	8.8	10.1	11.5	10.6	10.2	10.0abc
NewHy HWG	9.9	10.9	9.8	10.9	10.7	11.0	10.5	10.5ab
Critana TWG	8.7	10.5	9.9	12.4	10.6	11.3	11.5	10.7a
Regar MBG	7.1	10.1	7.9	12.2	9.5	9.5	11.8	9.7 bc
Average	8.6d ³	10.1bc	9.1cd	11.2a	10.4ab	10.2ab	11.0ab	
2006:								
Manska PWG	8.1	9.8	7.7	10.1	10.5	9.8	9.8	9.4 c
Oahe IWG	7.8	10.5	8.2	10.3	9.3	9.9	10.6	9.5 bc
NewHy HWG	8.5	10.8	9.6	10.9	9.9	10.5	10.3	10.1a
Critana TWG	8.0	12.0	8.6	10.6	10.1	11.2	10.5	10.1a
Regar MBG	8.6	11.3	8.0	10.6	10.6	11.2	10.6	10.1a
Average	8.2c	10.9a	8.4c	10.5ab	10.1b	10.5ab	10.3ab	

Table 4: Fertilized grass phosphorus contents (%) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	0.29	0.24	0.30	0.27	0.28	0.23	0.27	0.27ab ²
Oahe IWG	0.29	0.29	0.29	0.27	0.30	0.25	0.25	0.28a
NewHy HWG	0.24	0.30	0.22	0.25	0.27	0.24	0.27	0.25 b
Critana TWG	0.22	0.21	0.26	0.28	0.25	0.24	0.25	0.24 b
Regar MBG	0.22	0.21	0.22	0.31	0.30	0.25	0.24	0.25 b
Average	0.25ab ³	0.25ab	0.26ab	0.28a	0.28a	0.24b	0.24b	
2006:								
Manska PWG	0.20	0.17	0.21	0.20	0.21	0.22	0.23	0.21a
Oahe IWG	0.18	0.19	0.21	0.18	0.21	0.19	0.24	0.20a
NewHy HWG	0.20	0.21	0.22	0.19	0.21	0.21	0.21	0.21a
Critana TWG	0.25	0.18	0.19	0.20	0.19	0.21	0.21	0.20a
Regar MBG	0.19	0.21	0.20	0.21	0.23	0.20	0.22	0.21a
Average	0.20ab	0.19b	0.21ab	0.19b	0.21ab	0.21ab	0.22a	

¹PWG – pubescent wheatgrass; IWG – intermediate wheatgrass; HWG – hybrid wheatgrass; TWG – thickspike wheatgrass; MBG – meadow brome grass

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Table 5: Fertilized grass calcium contents (%) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	0.51	0.36	0.44	0.38	0.36	0.32	0.35	0.39a ²
Oahe IWG	0.40	0.36	0.34	0.34	0.38	0.34	0.31	0.35ab
NewHy HWG	0.32	0.35	0.34	0.38	0.35	0.34	0.33	0.35ab
Critana TWG	0.33	0.34	0.39	0.43	0.45	0.39	0.38	0.39a
Regar MBG	0.24	0.28	0.28	0.41	0.37	0.34	0.40	0.33 b
Average	0.36a ³	0.34a	0.36a	0.39a	0.38a	0.34a	0.35a	
2006:								
Manska PWG	0.52	0.48	0.46	0.47	0.49	0.45	0.49	0.48 b
Oahe IWG	0.47	0.47	0.45	0.50	0.44	0.45	0.46	0.46 b
NewHy HWG	0.36	0.40	0.43	0.41	0.37	0.39	0.43	0.40 c
Critana TWG	0.57	0.54	0.56	0.54	0.59	0.60	0.55	0.57a
Regar MBG	0.63	0.55	0.62	0.57	0.55	0.54	0.55	0.57a
Average	0.51a	0.49a	0.51a	0.50a	0.49a	0.49a	0.50a	

Table 6: Fertilized grass potassium contents (%) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	3.0	2.7	2.7	3.0	3.0	2.4	2.8	2.8 b ²
Oahe IWG	2.7	3.1	2.8	2.9	3.3	3.1	2.7	2.9ab
NewHy HWG	3.0	3.4	2.9	3.4	2.9	2.8	3.2	3.1a
Critana TWG	2.2	2.2	2.3	2.8	2.6	2.4	2.5	2.4 c
Regar MBG	3.1	2.8	2.7	3.6	3.0	3.0	3.2	3.1a
Average	2.8b ³	2.9ab	2.7b	3.1a	2.9ab	2.7b	2.9ab	
2006:								
Manska PWG	2.1	2.1	2.1	2.1	2.3	2.2	2.2	2.2 b
Oahe IWG	2.0	2.3	2.3	2.2	2.3	2.3	2.3	2.2 b
NewHy HWG	2.4	2.6	2.4	2.7	2.6	2.3	2.7	2.5a
Critana TWG	1.6	1.8	1.7	1.6	1.6	1.6	2.0	1.7 c
Regar MBG	2.3	2.4	2.2	2.7	2.5	2.4	2.6	2.4a
Average	2.1c	2.2bc	2.2bc	2.3ab	2.3ab	2.2bc	2.4a	

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Table 7: Fertilized grass magnesium contents (%) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	0.26	0.13	0.14	0.15	0.18	0.09	0.15	0.16a ²
Oahe IWG	0.21	0.21	0.19	0.16	0.15	0.13	0.09	0.16a
NewHy HWG	0.13	0.21	0.12	0.25	0.12	0.20	0.15	0.17a
Critana TWG	0.12	0.11	0.14	0.19	0.21	0.14	0.15	0.15a
Regar MBG	0.14	0.14	0.16	0.22	0.18	0.20	0.25	0.18a
Average	0.17a ³	0.16a	0.15a	0.19a	0.17a	0.15a	0.16a	
2006:								
Manska PWG	0.18	0.16	0.19	0.19	0.21	0.14	0.18	0.18 b
Oahe IWG	0.16	0.22	0.19	0.21	0.17	0.18	0.14	0.18 b
NewHy HWG	0.21	0.18	0.20	0.18	0.16	0.19	0.18	0.19 b
Critana TWG	0.21	0.19	0.18	0.18	0.20	0.18	0.17	0.19 b
Regar MBG	0.28	0.23	0.26	0.26	0.21	0.23	0.24	0.24a
Average	0.21a	0.19a	0.20a	0.20a	0.19a	0.18a	0.18a	

Table 8: Fertilized grass sulfur contents (%) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	0.24	0.16	0.22	0.18	0.18	0.16	0.18	0.19ab ²
Oahe IWG	0.24	0.18	0.22	0.20	0.19	0.17	0.17	0.20a
NewHy HWG	0.20	0.26	0.20	0.20	0.21	0.20	0.21	0.21a
Critana TWG	0.15	0.17	0.17	0.24	0.20	0.20	0.18	0.19ab
Regar MBG	0.15	0.16	0.16	0.19	0.16	0.15	0.17	0.16 b
Average	0.20a ³	0.19a	0.20a	0.20a	0.19a	0.18a	0.18a	
2006:								
Manska PWG	0.21	0.21	0.20	0.22	0.22	0.21	0.22	0.21 bc
Oahe IWG	0.24	0.25	0.23	0.26	0.23	0.25	0.26	0.24a
NewHy HWG	0.22	0.30	0.23	0.28	0.22	0.25	0.26	0.25a
Critana TWG	0.18	0.21	0.17	0.20	0.22	0.21	0.22	0.20 c
Regar MBG	0.23	0.25	0.21	0.22	0.21	0.23	0.23	0.22 b
Average	0.21c	0.24a	0.21c	0.24a	0.22bc	0.23ab	0.24a	

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Table 9: Fertilized grass iron contents (ppm) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	55.6	43.6	58.6	56.7	47.6	44.0	46.9	50.4a ²
Oahe IWG	52.2	48.4	50.7	50.2	56.5	51.1	45.7	50.7a
NewHy HWG	45.4	60.8	50.0	51.8	51.6	38.1	42.7	48.6a
Critana TWG	32.4	46.9	71.0	58.8	58.8	63.6	41.1	53.2a
Regar MBG	47.6	50.2	60.9	58.6	53.5	50.2	51.3	53.2a
Average	46.6bc ³	50.0abc	58.2a	55.2ab	53.6abc	49.4abc	45.5c	
2006:								
Manska PWG	55.4	51.7	48.8	50.2	54.9	60.5	60.2	54.5 c
Oahe IWG	54.0	66.7	57.5	62.0	58.1	61.6	59.6	59.9 c
NewHy HWG	48.3	62.3	60.4	63.4	58.0	57.8	64.0	59.2 c
Critana TWG	93.0	74.5	71.4	66.4	79.2	89.0	71.2	77.8a
Regar MBG	64.4	66.3	61.8	68.4	68.0	74.3	69.3	67.5 b
Average	63.0ab	64.3ab	60.0b	62.1ab	63.6ab	68.7a	64.8ab	

Table 10: Fertilized grass copper contents (ppm) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	8.6	8.4	8.3	8.2	6.7	7.0	8.7	8.0ab ²
Oahe IWG	7.8	11.2	8.3	8.6	9.2	6.8	9.2	8.7a
NewHy HWG	7.0	8.8	7.5	7.9	7.2	4.7	5.9	7.0 bc
Critana TWG	4.1	6.5	6.3	6.4	6.1	4.7	4.9	5.6 d
Regar MBG	5.4	6.0	4.3	7.0	6.3	5.3	7.9	6.0 cd
Average	6.6bc ³	8.2a	6.9b	7.6ab	7.1ab	5.7c	7.3ab	
2006:								
Manska PWG	8.5	8.9	8.3	7.5	7.9	8.0	8.7	8.3 b
Oahe IWG	11.2	8.2	8.7	9.7	10.4	9.9	9.2	9.6a
NewHy HWG	7.5	8.5	7.2	8.0	6.9	7.2	9.4	7.8 b
Critana TWG	5.6	4.7	5.4	5.3	6.4	5.2	5.1	5.4 c
Regar MBG	8.8	7.3	7.3	7.8	8.4	7.4	8.2	7.9 b
Average	8.3a	7.5a	7.4a	7.7a	8.0a	7.5a	8.1a	

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³Fertilizer treatment averages within a year not connected by the same letter are significantly different at the 0.05 level of probability.

Table 11: Fertilized grass manganese contents (ppm) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	74.5	51.1	60.9	52.6	42.0	43.9	35.1	51.4a ²
Oahe IWG	59.8	34.7	39.4	47.6	46.8	46.4	43.9	45.5ab
NewHy HWG	25.6	29.8	36.5	34.0	31.4	31.9	44.3	33.4 cd
Critana TWG	24.8	21.8	23.4	22.5	26.2	29.2	22.3	24.3 d
Regar MBG	41.9	31.7	33.7	43.0	37.6	48.9	56.3	41.9 bc
Average	45.3a ³	33.8b	38.8ab	39.9ab	36.8ab	40.1ab	40.4ab	
2006:								
Manska PWG	47.3	50.4	45.2	39.9	53.4	44.8	50.7	47.4 b
Oahe IWG	48.9	44.1	47.1	48.0	53.1	46.8	42.1	47.2 b
NewHy HWG	29.3	26.8	29.6	32.2	33.8	34.1	40.2	32.3 c
Critana TWG	36.0	34.6	38.5	30.3	77.9	39.7	50.7	44.0 b
Regar MBG	61.2	48.7	61.1	62.4	101.3	74.2	79.6	69.8a
Average	44.5bc	40.9c	44.3bc	42.6c	63.9a	47.9bc	52.6b	

Table 12: Fertilized grass zinc contents (ppm) at Daly's in 2005 and 2006.

Grass	Control	N	P	N + P	Nitrogen + Phosphorus +			Average
					Mn	Zn	Mn + Zn	
2005:								
Manska PWG ¹	21.3	18.1	19.3	19.6	18.5	17.7	20.0	19.2a ²
Oahe IWG	25.1	21.6	18.9	20.8	23.4	18.0	21.3	21.3a
NewHy HWG	16.1	18.5	14.3	15.7	14.5	15.2	12.7	15.3 b
Critana TWG	12.2	13.9	14.2	12.5	15.3	17.6	14.8	14.4 b
Regar MBG	12.9	12.9	12.7	17.5	16.4	11.8	15.4	14.2 b
Average	17.5a ³	17.0a	15.9a	17.2a	17.6a	16.1a	16.8a	
2006:								
Manska PWG	16.8	19.3	16.2	19.0	18.9	32.5	27.5	21.5ab
Oahe IWG	18.7	19.5	18.7	21.9	20.9	43.6	26.8	24.3ab
NewHy HWG	16.0	14.4	15.4	19.0	16.2	23.1	29.3	19.0 b
Critana TWG	14.9	14.8	15.0	15.5	14.7	78.7	41.0	27.8a
Regar MBG	11.7	11.8	12.6	13.5	15.0	64.8	47.9	25.3ab
Average	15.6c	15.9c	15.6c	17.8c	17.1c	48.5a	34.5b	

¹PWG – pubescent wheatgrass; IWG – intermediate wheatgrass; HWG – hybrid wheatgrass; TWG – thickspike wheatgrass; MBG – meadow brome grass

²Grass averages within a year not connected by the same letter are significantly different at the 0.05 level of probability.

³Fertilizer treatment averages within a year not connected by the same letter are significantly different at the 0.05 level of probability.

Fertilizer Affects on Irrigated Cool Season Grass Hay Yields & Quality at Larry Vignaroli's

In 2006 the cool-season grasses for the hay production study at Larry Vignaroli's [Luna and Mandan pubescent wheatgrass (PWG); NewHy hybrid wheatgrass (HWG); Rosana western wheatgrass (WWG); Critana thick-spike wheatgrass (TWG); Hycrest crested wheatgrass (CWG); Bozoisky Russian wild-rye (RWR); Manchar smooth brome grass (SBG); and Regar meadow brome grass (MBG)] were subjected to four fertilizer treatments: No fertilizer (Control); 33 lb N/acre applied on 12 May (N1); 33 lb N/acre applied on 12 May and 23 August, respectively (N2); and 39 lb N/acre + 19 lb P/ac (N+P) applied on 12 May. Grass varieties and fertilizer treatments were replicated three times.

Because April and May 2006 precipitation was lacking irrigation water was applied during the third week of May.

Soil samples collected from the plot area on 12 May 2006 prior to fertilizer application and on 24 October 2006 from each fertilizer treatment were analyzed for nitrate-N and P.

Each grass was harvested to a two-inch stubble height from each fertilizer treatment on 26 June 2006 to determine hay yield and forage quality.

Grass forage quality and soil analyses were performed by the University of Nebraska Soil and Plant Analytical Lab.

Nitrogen fertilizer increased grass hay yields by an average of 810 lb/ac with the lowest increase for Bozoisky RWR at 150 lb/ac and the highest increase for Mandan and Luna PWG, NewHy HWG, and Manchar SBG

with an average of 1070 lb/ac (Table 1). The increase in hay yields with 33 and 39 lb N/ac indicates that higher N levels may have warranted. Application of P fertilizer did not appear to affect grass hay yields for any of the grasses. The two PWG varieties had the highest average hay yields at 4830 lb/ac and Critana TWG the lowest at 2380 lb/ac.

Nitrogen fertilizer cost \$19 and \$22 for 33 and 39 lb N/ac, respectively, application cost \$4/ac, and hay brought \$100/T in 2006. All the grasses, except Bozoisky RWR and Hycrest CWG, resulted in an average profit of \$20/ac with the application of 33 lb N/ac. If the cost of 19 lb P/ac (\$8) was included there would have been an average profit of \$8/ac for the HWG, the two PWG, and the brome grasses. Any profits or losses for applying an additional 33 lb N/ac in August 2006 will not be realized until 2007 hay yields of the grasses are determined.

Net Energy maintenance (NEm) content of the grasses among fertilizer treatments was similar (Table 2). Luna and Mandan PWG, Critana TWG, and Regar MBG contained the lowest average amounts of NEm but their amounts were sufficient to meet the needs of a lactating beef cow and sheep ewe (0.60 Mcal/lb).

Nitrogen fertilizer increased grass crude protein content by an average of 0.6% (Table 3). However, the grasses, regardless of fertilizer treatment, contained an adequate amount of crude protein to meet the needs of a lactating beef cow and a late gestating sheep ewe (10.7%).

The soil contained 3.0 ppm nitrate-N on 12 May 2006. On 24 October 2006 soil from the Control, N1, N2, and N+P fertilizer treatments contained an average of 2.9, 3.7, 3.5, and 3.0 ppm nitrate-N, respectively.

Phosphorus fertilizer may not have resulted in an increase in grass P content compared to the Control treatment, but it may have offset the negative affect N fertilizer appeared to have on grass P content (Table 4). Among the grasses P content was similar but generally not adequate for a lactating beef cow (0.21%) or for a sheep ewe in gestation or lactation (0.20 – 0.29%).

Soil P content on 12 May 2006 was 22 ppm and on 24 October 2006 it averaged 21, 20, 32, and 20 ppm in the Control, N1, N2, and N+P fertilizer treatments, respectively.

Nitrogen fertilizer, with or without phosphorus, did not significantly affect the amount of calcium (Ca), potassium (K), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu) found in the grasses (Tables 5 – 12).

Hycrest CWG contained the lowest Ca amounts among the grasses (Table 5) and, except from the Control treatment, it did not contain enough Ca for a lactating ewe nursing twins (0.39%).

Hycrest CWG also contained the lowest average amount of K (Table 6) but was still at a level twice the amount needed by a lactating beef cow and sheep ewe (0.70 – 0.80%).

Hycrest CWG did not contain an adequate amount of Mg to meet the needs of a lactating beef cow (0.20%) and for a sheep ewe (0.18%), except from the Control treatment (Table 7). Critana TWG and Rosana WWG from the N fertilized treatments generally did not contain an adequate amount of Mg to meet the needs of a lactating beef cow or sheep ewe. Nitrogen fertilizer may have had a negative impact on grass uptake of Mg.

Sulfur (%) and iron (ppm) contents varied among the grasses (Tables 8 and 9) but were sufficient in all to meet the needs of a beef cow (0.15% and 50 ppm) and sheep ewe (0.14 – 0.18% and 30 ppm).

All the grasses, regardless of fertilizer treatment (Table 10), contained an adequate amount of Mn to meet the needs of a sheep ewe (20 ppm). However, Hycrest CWG and Critana TWG did not contain a sufficient amount to meet the needs of a beef cow (40 ppm) from all fertilizer treatments.

None of the grasses, regardless of fertilizer treatment (Table 11), contained enough Zn to meet the needs of a beef cow (30 ppm) or a sheep ewe (33 ppm).

NewHy HWG contained a sufficient amount of Cu to meet the needs of a beef cow and sheep ewe in all production stages (10 ppm). The other grasses, except Hycrest CWG and Critana TWG, contained enough Cu to meet the needs of a lactating ewe (8 ppm) but not one in gestation (10 ppm).

Management Implications:

If April precipitation is well below normal irrigation water should be applied in early May. If nitrogen fertilizer is to be used it should be applied by mid-May at the latest. Phosphorus fertilizer may not be needed unless a soil test indicates so. Further study needs to be done on Mn and Zn fertilizers.

References:

- Nutrient Requirements of Beef Cattle, 7th rev. ed., 1996, National Research Council, National Academy of Sciences, Washington, D.C. (1200 lb cow)
- Nutrient Requirements of Sheep, 6th rev. ed., 1985, National Research Council, National Academy of Sciences, Washington, D.C. (200 lb ewe)

Table 1: Fertilized grass hay yields (lb/ac) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	3070	3590	2850	3220	3160	3170 bc ¹
Hycrest crested wheatgrass	4240	5330	4000	4670	4500	4520a
NewHy hybrid wheatgrass	2490	4540	2500	3520	3610	3290 bc
Luna pubescent wheatgrass	4040	5130	4990	5060	5110	4820a
Mandan pubescent wheatgrass	3960	5690	4570	5130	5150	4840a
Critana thickspike wheatgrass	1830	2430	2930	2680	2330	2380 c
Rosana western wheatgrass	3090	3390	4420	3900	3760	3670abc
Manchar smooth bromegrass	3280	4060	4610	4340	4340	4070ab
Regar meadow bromegrass	2540	2910	3630	3270	3810	3220 bc
Average	3170a ²	4120a	3830a	3980	3970a	

Table 2: Fertilized grass net energy maintenance contents (Mcal/lb) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	0.66	0.62	0.64	0.63	0.63	0.64ab ¹
Hycrest crested wheatgrass	0.60	0.65	0.64	0.65	0.65	0.64ab
NewHy hybrid wheatgrass	0.64	0.62	0.66	0.64	0.65	0.64a
Luna pubescent wheatgrass	0.60	0.59	0.60	0.60	0.59	0.60 d
Mandan pubescent wheatgrass	0.61	0.61	0.61	0.61	0.60	0.61 cd
Critana thickspike wheatgrass	0.59	0.58	0.61	0.60	0.58	0.59 d
Rosana western wheatgrass	0.65	0.65	0.63	0.64	0.66	0.65a
Manchar smooth bromegrass	0.69	0.64	0.67	0.66	0.61	0.65a
Regar meadow bromegrass	0.63	0.63	0.59	0.61	0.62	0.62 bcd
Average	0.63a ²	0.62a	0.63a	0.62	0.62a	

Table 3: Fertilized grass crude protein contents (%) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	12.7	13.5	14.8	14.1	13.8	13.7a ¹
Hycrest crested wheatgrass	9.8	10.3	10.9	10.6	10.1	10.3 e
NewHy hybrid wheatgrass	14.3	12.3	12.8	12.6	13.8	13.3ab
Luna pubescent wheatgrass	10.4	10.2	10.8	10.5	10.8	10.6 e
Mandan pubescent wheatgrass	10.3	11.6	11.6	11.6	10.5	11.0 de
Critana thickspike wheatgrass	11.1	11.6	12.8	12.2	12.1	11.9 cd
Rosana western wheatgrass	13.4	12.5	12.7	12.6	11.6	12.6 bc
Manchar smooth bromegrass	10.4	12.7	12.4	12.6	13.1	12.2 c
Regar meadow bromegrass	10.9	12.7	12.1	12.4	12.6	12.1 cd
Average	11.5b ²	11.9ab	12.3a	12.1	12.0ab	

¹Grass averages not connected by the same letter are significantly different at the 0.05 level of probability.

²Fertilizer treatment averages not connected by the same letter are significantly different at the 0.05 level of probability.

Table 4: Fertilized grass phosphorus contents (%) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	0.21	0.18	0.23	0.20	0.23	0.21a ¹
Hycrest crested wheatgrass	0.18	0.18	0.19	0.19	0.21	0.19ab
NewHy hybrid wheatgrass	0.20	0.19	0.17	0.18	0.22	0.20ab
Luna pubescent wheatgrass	0.19	0.17	0.18	0.18	0.21	0.19ab
Mandan pubescent wheatgrass	0.22	0.17	0.19	0.18	0.19	0.19ab
Critana thickspike wheatgrass	0.24	0.21	0.15	0.18	0.23	0.21a
Rosana western wheatgrass	0.17	0.17	0.21	0.19	0.16	0.18 b
Manchar smooth bromegrass	0.18	0.15	0.18	0.17	0.20	0.18 b
Regar meadow bromegrass	0.18	0.12	0.18	0.15	0.24	0.18 b
Average	0.20ab ²	0.17c	0.19bc	0.18	0.21a	

Table 5: Fertilized grass calcium contents (%) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	0.57	0.58	0.58	0.58	0.50	0.56 bc ¹
Hycrest crested wheatgrass	0.40	0.34	0.37	0.36	0.35	0.37 d
NewHy hybrid wheatgrass	0.62	0.54	0.63	0.59	0.60	0.60 b
Luna pubescent wheatgrass	0.59	0.59	0.53	0.56	0.51	0.56 bc
Mandan pubescent wheatgrass	0.54	0.45	0.50	0.48	0.48	0.49 c
Critana thickspike wheatgrass	0.57	0.53	0.47	0.50	0.55	0.53 bc
Rosana western wheatgrass	0.55	0.48	0.57	0.52	0.48	0.52 bc
Manchar smooth bromegrass	0.68	0.48	0.46	0.47	0.56	0.55 bc
Regar meadow bromegrass	0.76	0.80	0.55	0.68	0.73	0.71a
Average	0.59a ²	0.53b	0.52b	0.53	0.53b	

Table 6: Fertilized grass potassium contents (%) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	3.63	3.46	3.62	3.54	3.51	3.56a ¹
Hycrest crested wheatgrass	1.62	1.88	1.67	1.78	1.80	1.74 e
NewHy hybrid wheatgrass	3.06	2.93	3.11	3.02	3.22	3.08 b
Luna pubescent wheatgrass	2.49	2.60	2.54	2.57	2.58	2.55 c
Mandan pubescent wheatgrass	2.70	2.41	2.82	2.61	2.66	2.65 c
Critana thickspike wheatgrass	2.14	2.30	2.19	2.24	2.25	2.22 d
Rosana western wheatgrass	2.66	2.45	2.83	2.64	2.71	2.66 c
Manchar smooth bromegrass	2.41	2.53	2.34	2.43	2.62	2.48 c
Regar meadow bromegrass	2.78	3.13	3.14	3.13	3.39	3.11 b
Average	2.61b ²	2.63ab	2.70ab	2.66	2.75a	

¹Grass averages not connected by the same letter are significantly different at the 0.05 level of probability.

²Fertilizer treatment averages not connected by the same letter are significantly different at the 0.05 level of probability.

Table 7: Fertilized grass magnesium contents (%) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	0.37	0.31	0.32	0.31	0.23	0.31ab ¹
Hycrest crested wheatgrass	0.18	0.16	0.16	0.16	0.14	0.16 d
NewHy hybrid wheatgrass	0.31	0.22	0.28	0.25	0.18	0.25 bc
Luna pubescent wheatgrass	0.22	0.24	0.16	0.20	0.29	0.23 c
Mandan pubescent wheatgrass	0.26	0.27	0.21	0.24	0.21	0.24 c
Critana thickspike wheatgrass	0.22	0.15	0.22	0.19	0.15	0.19 cd
Rosana western wheatgrass	0.22	0.13	0.18	0.16	0.19	0.18 cd
Manchar smooth brome grass	0.22	0.23	0.19	0.21	0.34	0.25 bc
Regar meadow brome grass	0.40	0.35	0.28	0.32	0.40	0.36a
Average	0.27a ²	0.23a	0.22a	0.23	0.24a	

Table 8: Fertilized grass sulfur contents (%) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	0.30	0.32	0.33	0.32	0.33	0.32a ¹
Hycrest crested wheatgrass	0.22	0.25	0.24	0.25	0.26	0.24 def
NewHy hybrid wheatgrass	0.30	0.24	0.30	0.27	0.30	0.29 b
Luna pubescent wheatgrass	0.19	0.22	0.24	0.23	0.20	0.21 f
Mandan pubescent wheatgrass	0.23	0.22	0.24	0.23	0.21	0.23 ef
Critana thickspike wheatgrass	0.19	0.23	0.23	0.23	0.22	0.22 ef
Rosana western wheatgrass	0.27	0.24	0.26	0.25	0.23	0.25 cde
Manchar smooth brome grass	0.23	0.27	0.25	0.26	0.32	0.27 bcd
Regar meadow brome grass	0.26	0.31	0.26	0.29	0.28	0.28 bc
Average	0.24a ²	0.26a	0.26a	0.26	0.26a	

Table 9: Fertilized grass iron contents (ppm) at Vignaroli's in 2006.

Grass	Control	N1	N2	N Avg.	N + P	Average
Bozoisky Russian wildrye	119	144	130	137	132	131ab ¹
Hycrest crested wheatgrass	59	77	70	73	66	68 d
NewHy hybrid wheatgrass	90	74	108	91	115	97 cd
Luna pubescent wheatgrass	68	76	80	78	98	80 d
Mandan pubescent wheatgrass	127	70	100	85	82	95 cd
Critana thickspike wheatgrass	136	141	113	127	130	130 b
Rosana western wheatgrass	157	90	142	116	93	121 bc
Manchar smooth brome grass	86	78	86	82	106	89 cd
Regar meadow brome grass	126	150	216	183	156	162a
Average	108a ²	100a	116a	108	109a	

¹Grass averages not connected by the same letter are significantly different at the 0.05 level of probability.

²Fertilizer treatment averages not connected by the same letter are significantly different at the 0.05 level of probability.

Table 10: Fertilized grass manganese contents (ppm) at Vignaroli's in 2006.

<u>Grass</u>	<u>Control</u>	<u>N1</u>	<u>N2</u>	<u>N Avg.</u>	<u>N + P</u>	<u>Average</u>
Bozoisky Russian wildrye	45	41	39	40	34	40 bc ¹
Hycrest crested wheatgrass	23	17	23	20	20	21 d
NewHy hybrid wheatgrass	58	44	46	45	60	52a
Luna pubescent wheatgrass	63	58	53	55	54	57a
Mandan pubescent wheatgrass	61	49	52	50	47	52a
Critana thickspike wheatgrass	36	35	33	34	33	34 c
Rosana western wheatgrass	46	37	55	46	36	44 b
Manchar smooth bromegrass	54	49	59	54	55	54a
Regar meadow bromegrass	47	57	49	53	54	52a
Average	48a ²	43a	45a	44	44a	

Table 11: Fertilized grass zinc contents (ppm) at Vignaroli's in 2006.

<u>Grass</u>	<u>Control</u>	<u>N1</u>	<u>N2</u>	<u>N Avg.</u>	<u>N + P</u>	<u>Average</u>
Bozoisky Russian wildrye	17	18	18	18	17	18 b ¹
Hycrest crested wheatgrass	18	17	19	18	19	18 b
NewHy hybrid wheatgrass	24	21	22	22	24	23a
Luna pubescent wheatgrass	20	25	21	23	23	22a
Mandan pubescent wheatgrass	21	21	24	22	22	22a
Critana thickspike wheatgrass	18	16	18	17	16	17 b
Rosana western wheatgrass	26	21	23	22	24	24a
Manchar smooth bromegrass	20	26	23	24	21	23a
Regar meadow bromegrass	14	17	15	16	17	16 b
Average	20a ²	20a	20a	20	20a	

Table 12: Fertilized grass copper contents (ppm) at Vignaroli's in 2006.

<u>Grass</u>	<u>Control</u>	<u>N1</u>	<u>N2</u>	<u>N Avg.</u>	<u>N + P</u>	<u>Average</u>
Bozoisky Russian wildrye	6.9	7.0	8.8	7.9	5.8	7.1 c ¹
Hycrest crested wheatgrass	6.3	7.9	7.4	7.7	6.1	6.9 c
NewHy hybrid wheatgrass	10.9	12.1	9.3	10.7	12.6	11.2a
Luna pubescent wheatgrass	8.1	12.9	8.6	10.7	9.3	9.7ab
Mandan pubescent wheatgrass	10.4	6.3	10.5	8.4	8.3	8.9 bc
Critana thickspike wheatgrass	6.7	7.1	7.5	7.3	8.4	7.4 c
Rosana western wheatgrass	6.4	8.0	10.9	9.5	9.2	8.6 bc
Manchar smooth bromegrass	7.0	8.5	9.0	8.8	7.4	8.0 bc
Regar meadow bromegrass	10.6	9.9	9.2	9.6	9.1	9.7ab
Average	8.2a ²	8.9a	9.0a	8.9	8.5a	

¹Grass averages not connected by the same letter are significantly different at the 0.05 level of probability.

²Fertilizer treatment averages not connected by the same letter are significantly different at the 0.05 level of probability.

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