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Affect of Nitrogen and Phosphorus Fertilizers on Irrigated Perennial Cool Season Grass Hay Production

A trial to determine cost/benefit of nitrogen (N) and phosphorus (P) fertilization for irrigated grass hay production was conducted at the Larry Vignaroli Ranch along lower Clear Creek in Johnson County, Wyoming.

Replicated plots of Bozoisky Russian wildrye (RWR); NewHy hybrid wheatgrass (HWG); Luna and Mandan pubescent wheatgrass (PWG); Manchar smooth bromegrass (SBG); and Regar meadow bromegrass (MBG) planted in May 2003 were subjected to four fertilizer treatments in 2007, 2008, and 2009: No fertilizer (Control); 100 lb N/ac in early May (N1); 100 lb N/ac in early May and again in mid-July (N2); and 100 lb N/ac plus P @ 58 lb/ac in 2007 and 100 lb/ac in 2009 in early May (N+P). Note: Fertilizer rates are actual nutrient amounts. The amount of fertilizer to apply per acre is based on the desired nutrient amount and the level contained in the fertilizer. For example: Urea contains 46 lb of N per 100 lb of fertilizer (46% N). If the desired amount of N is 100 lb/ac then 217 lb of urea (100 ÷ 0.46) would need to be applied per acre.

The grass plots were located within an alfalfa field irrigated by flood method. No spring irrigation occurred in 2007 due to adequate precipitation; irrigations occurred in mid-May 2008 and 2009, and each summer.

Data Collection
Herbage from each grass x fertilizer treatment was harvested on 20 June 2007, 24 June 2008, and 24 June 2009 to determine potential hay yields (10% moisture). In addition, regrowth of each grass x fertilizer treatment was harvested on 3 October 2007, 7 October 2008, and 28 September 2009 to determine potential grazable forage on a hay yield basis.

Soil samples from each fertilizer treatment were collected on 24 October 2006, 1 October 2007, and 27 April 2009 and analyzed for nitrate-N, ammonium-N (2009 only), and phosphorus by the University of Nebraska Soil and Plant Analytical lab (2006 and 2007 samples) and by the University of Missouri Soil and Plant Testing lab (2009 samples).

Results and Discussion

For 2007 and 2008 results and discussion see December 2008 Land & Livestock (Grass Hay Studies). If you do not have a copy of this newsletter you can obtain one from the Johnson County Extension office or at the following web site:

http://uwadmnweb.uwyo.edu/JohnsonCES/Johnson/Newsletters/Johnson_Newsletters_main.htm

Because Hycrest crested wheatgrass and Rosana western wheatgrass have been significantly overtaken by the other grasses, they were excluded in this year's study.

24 June 2009

The grasses produced an average of 0.8 T/ac more hay from the N1 treatment compared to the Control (Table 1). Late April 2009 total soil available N (nitrate-N + ammonium-N) averaged 16 and 25 ppm for the Control and N1 treatments, respectively. In addition, grass hay yields averaged 0.5 T/ac more from the N2 treatment compared to the N1 treatment. Total soil N for the N2 treatment averaged 13 ppm higher compared to the N1 treatment. This higher available soil N most likely was carryover from the 15 July 2008 application.

Except for Bozoisky RWR and Manchar SBG which produced more hay from the N2 treatment, the other grasses produced more hay from the N+P treatment by an average of 0.9 T/ac (Table 1). Total available soil N for the N+P treatment was similar to that for the N1 treatment at 26 ppm but available soil P for the N+P treatment averaged 31 ppm compared to 20, 19, and 12 ppm for the Control, N1, and N2 treatments, respectively. The greater amount of soil P in the N+P treatment may be the contributing factor for the higher hay yields from this treatment. This higher soil P level was probably due to the May 2007 P fertilizer application as the soil samples were collected prior to this year's application. Had soil samples been collected in fall 2008 and analyzed over winter a spring 2009 application of P fertilizer would have probably not been done.

At $70 per ton for good quality grass hay (9 – 13% crude protein) Manchar SBG would have generated the most income from the Control treatment followed by NewHy HWG and then Regar MBG (Table 2). However, the 100 lb N/ac (N1) applied on 1 May resulted in no increase in profit for Manchar SBG, whereas for Mandan PWG and Regar MBG they produced enough additional hay to result in an average of $43 per acre more income compared to the Control treatment.

Previous year's split applications of N (N2) resulted in the grasses producing enough additional hay to realize an average additional profit of $32, $35, and $14 per acre compared to the Control, N1, and N+P treatments, respectively (Table 2). This was especially true for Manchar SBG which averaged $70/ac additional net income from the N2 treatment compared to the other three treatments.

Whether or not the April 2009 application of 100 lb P/ac with 100 lb N/ac was the reason for the higher average hay yields for the N+P treatment compared to the other treatments is not clear. As noted above available soil P was already sufficiently high in this treatment and average grass hay yields in June 2008 were similar in this treatment to this year's. Thus, the P applied this year may or may not have

contributed to late spring grass growth but should be available to the grasses for the next three to five years and pay dividends then. However, P cost was subtracted from income and even with that an average of nearly $20/ac more net income was generated from this treatment compared the N1 treatment (Table 2). If the 1 May 2009 application of P did not occur and yields were still similar net income would have been ≈ $48/ac more.

28 September 2009

The application of 100 lb N/ac on 15 July 2009 (N2) resulted in the grasses producing an average of 0.7 T/ac more hay compared to the Control, N1, and N+P treatments with Manchar SBG having the highest difference of 1.2 T/ac (Table 1). There apparently was some residual N in the soil from the 1 May N application for the N1 and N+P treatments as the grasses yielded an average of 0.4 T/ac more hay from these two treatments compared to the Control. The P fertilizer applied on 1 May might have contributed some to late summer grass growth as hay yields from the N+P treatment averaged 0.2 T/ac more compared to the N1 treatment.

Regar MBG had the highest net income among the grasses from the Control, N1, and N+P treatments at an average of $96/ac followed by NewHy HWG at $84/ac (Table 2). Net income for Manchar SBG from the N2 treatment averaged $25/ac more compared to the Control, N1, and N+P treatments, whereas for the other grasses cost of the additional N resulted in an average net loss in income.

Total Grass Hay Yields for 2009

Total grass hay yields (24 Jun + 28 Sep) averaged 1.2 T/ac more from the N2 and N+P treatments compared to the N1 treatment and over 2.3 T/ac more compared to the Control (Table 1). Regar MBG and Manchar SBG produced an average of 3.7 T/ac from the Control out yielding the other grasses by an average of 0.8 T/ac. In addition, these two grasses yielded an average of 1.4, 2.8, and 2.5 T/ac more hay from the N1, N2, and N+P treatments, respectively, compared to the Control. The two bromes also averaged 1.3, 1.6, and 1.1 T/ac more hay compared to the other grasses from the N1, N2, and N+P treatments, respectively.

Highest total net income was obtained from the N2 treatment for Manchar SBG and from the N+P treatment for Regar MBG (Table 2). Regar MBG had the highest average net income over the four treatments.

Total June Hay Yields: 2007+2008+2009

Regar MBG, Manchar SBG, and Mandan and Luna PWG produced an average of 11.8 T/ac of hay from the N1 treatment compared to 7.8 T/ac from the Control (Table 3). Thus net hay income for these four grasses averaged about $200/ac more from the N1 treatment compared to the Control (Table 4).

P at 58 lb/ac in May 2007 and 100 lb/ac in 2009 along with 100 lb N/ac all three years resulted in an average of 1.9 T/ac more grass hay compared to that harvested from the N1 treatment (Table 3). Total June hay yields for Regar MBG were 2.8 and 6.7 T/ac more from the N+P treatment compared to the N1 and Control treatments resulting in an extra net income of $190 and $335/ac, respectively (Table 4). In addition, net hay income for Manchar SBG from the N+P treatment was $117 and $288/ac more compared to the N1 and Control treatments, respectively.

Manchar SBG produced the most June hay from the N2 treatment compared to the other grasses, except for Regar MBG, and it yielded 6.5 and 2.6 T/ac more hay compared to what it produced from the Control and N1 treatments, respectively (Table 3). As a result total net income for Manchar SBG from the N2 treatment was $408, $237, and $120 per

acre more compared to the amounts received from the Control, N1, and N+P treatments, respectively (Table 4).

Total Fall Hay Yields: 2007+2008+2009

Without fertilization Luna and Mandan PWG produced the least amount of total late summer regrowth compared to the other grasses by an average of 0.7 T/ac (Table 3). July applications of 100 lb N/ac (N2) resulted in over twice as much hay produced from this treatment by the grasses compared to the Control and 1.8 T/ac more compared to the N1 and N+P treatments. Although total fall hay yields from the N2 treatment were not statistically different among the grasses yields of Bozoisky RWR and Luna PWG averaged 1.4 T/ac less. Residual N and possibly P from spring applications (N1 and N+P) resulted in the grasses producing an average of 0.9 T/ac more hay compared to the Control.

Highest net income from fall harvested hay was from the N+P treatment for NewHy HWG followed by Regar MBG (Table 4) even though total yields of both grasses were 1.3 T/ac less compared to their N2 treatment yields (Table 3). NewHy HWG and Regar MBG also had the third and fourth highest net incomes, respectively, from the N1 treatment.

Total Hay Yields: 2007+2008+2009

The N2 and N+P treatments produced more total grass hay over the three years compared to the N1 and Control treatments by an average of three and seven T/ac, respectively (Table 3). Manchar SBG produced the most total hay among the grasses from these two treatments at nearly 20 T/ac with Regar MBG yielding nearly 19 T/ac. Both of these grasses also produced the most hay from the N1 treatment at over 15 T/ac.

The highest amount of total net income would have been obtained for Manchar SBG from the N2 treatment followed by Regar MBG from the N+P treatment (Table 4). In addition, total net income of both of these grasses from the N1 treatment was similar and around $240/acre more compared to the Control.

Summary

June hay yields among the grasses with no N or P fertilizer were similar, except for Bozoisky RWR which had the least, and late summer regrowth was similar, except for Luna and Mandan PWG which had the lowest. The increase in grass June hay yields due to the 100 lb N/ac applied in May was sufficient to exceed fertilization costs, except for Bozoisky RWR and NewHy HWG. In addition, late summer grass regrowth was greater from the May N applications compared to no N. June hay yields for Luna and Mandan PWG were not improved with May and July applications of 100 lb N/ac compared to their yields with just the May application. Although late summer regrowth was greater for all the grasses when 100 lb N/ac was applied in May and July compared to May only it generally was not enough to offset cost of the July application, except when June hay yields were included, especially for Manchar SBG. Phosphorus at 58 lb/ac in May 2007 and 100 lb/ac in May 2009 along with 100 lb N/ac all three years generally did not result in enough of an increase in June hay yields and late summer regrowth to offset the cost of P fertilizer, except for Manchar SBG and Regar MBG.

Manchar SBG and Regar MBG generally produced the most June hay regardless of fertilizer treatment followed by Mandan and Luna PWG. The two bromes also generally had the most late summer regrowth along with NewHy HWG but it was least for the two pubescent wheatgrasses.

Although 100 lb N/ac in early May resulted in a positive cost/benefit, especially for June hay yields, it is recommended to soil test first.

Table 1: Grass hay yields in tons per acre (Least Squares Means) for each fertilizer treatment at the Larry Vignaroli Ranch along lower Clear Creek, northern Johnson County in 2009.

	Fertilizer Treatments			
Grasses	Control	N1	N2	N+P
24 June Harvest:				
Bozoisky Russian wildrye	1.7 b[1]	2.4 c	3.5 ab	3.2 c
NewHy hybrid wheatgrass	2.7 ab	2.6 c	3.2 b	3.9 b
Luna pubescent wheatgrass	2.4 ab	3.1 bc	3.3 b	3.8 b
Mandan pubescent wheatgrass	2.1 ab	3.6 ab	3.6 ab	4.9 ab
Manchar smooth bromegrass	2.8 a	3.7 ab	4.7 a	4.4 ab
Regar meadow bromegrass	2.7 ab	4.1 a	4.0 ab	5.0 a
Average	*2.4 D*[2]	*3.2 C*	*3.7 B*	*4.2 A*
28 September Harvest:				
Bozoisky Russian wildrye	0.7 ab	0.9 ab	1.3 b	0.7 b
NewHy hybrid wheatgrass	0.7 ab	1.2 a	1.7 ab	1.8 a
Luna pubescent wheatgrass	0.6 b	0.9 ab	1.7 ab	1.0 ab
Mandan pubescent wheatgrass	0.5 b	0.7 b	1.3 b	0.8 ab
Manchar smooth bromegrass	0.8 ab	0.9 ab	2.2 a	1.2 ab
Regar meadow bromegrass	1.0 a	1.4 a	2.0 ab	1.7 a
Average	*0.7 C*	*1.0 B*	*1.7 A*	*1.2 B*
Total June & September:				
Bozoisky Russian wildrye	2.5 c	3.3 c	4.8 b	3.9 c
NewHy hybrid wheatgrass	3.4 abc	3.8 bc	4.9 b	5.7 ab
Luna pubescent wheatgrass	3.0 abc	4.0 bc	5.0 b	4.8 bc
Mandan pubescent wheatgrass	2.6 bc	4.2 bc	4.9 b	5.6 ab
Manchar smooth bromegrass	3.6 ab	4.6 ab	6.9 a	5.6 ab
Regar meadow bromegrass	3.7 a	5.5 a	6.1 ab	6.7 a
Average	*3.1 C*	*4.2 B*	*5.4 A*	*5.4 A*

[1]Grass hay yield means within a fertilizer treatment for each hay harvest and total followed by the same small letter are not significantly different at the 0.05 level of probability.

[2]Grass hay yield average means across fertilizer treatments for each hay harvest and total followed by the same capital letter are not significantly different at the 0.05 level of probability.

Table 2: Grass hay net income ($/acre) after fertilizer costs[1] for each fertilizer treatment at the Larry Vignaroli Ranch along lower Clear Creek, northern Johnson County in 2009.

	Fertilizer Treatments			
Grasses	Control	N1	N2	N+P
24 June Harvest:				
Bozoisky Russian wildrye	121	106	186	120
NewHy hybrid wheatgrass	190	119	163	166
Luna pubescent wheatgrass	170	154	173	157
Mandan pubescent wheatgrass	146	188	189	231
Manchar smooth bromegrass	199	199	270	201
Regar meadow bromegrass	187	230	223	243
28 September Harvest:				
Bozoisky Russian wildrye	51	63	8	51
NewHy hybrid wheatgrass	50	86	44	117
Luna pubescent wheatgrass	43	62	59	72
Mandan pubescent wheatgrass	38	46	14	56
Manchar smooth bromegrass	53	62	90	80
Regar meadow bromegrass	73	98	82	116
Total June + September:				
Bozoisky Russian wildrye	172	169	194	170
NewHy hybrid wheatgrass	240	205	208	283
Luna pubescent wheatgrass	213	216	233	228
Mandan pubescent wheatgrass	183	234	202	287
Manchar smooth bromegrass	252	261	360	282
Regar meadow bromegrass	260	328	304	358

[1]Grass hay price: $70/T from USDA-WY Dept Ag Market News, Torrington, WY
Fertilizer costs: Control (Jun and Sep Harvests) - No fertilizer and application costs;
N1 & N2 (Jun) - 294 lb/ac (34-0-0) @ $375/T = $55/ac + $5/ac application cost = $60/ac;
N+P (Jun) - 232 lb/ac (34-0-0) @ $375/T = $43/ac + 192 lb/ac (11-52-0) @ $620/T = $60/ac + $5/ac application cost = $108/ac,
N1 & N+P (Sep) - No fertilizer and application costs;
N2 (Sep) - 294 lb/ac (34-0-0) @ $375/T = $55/ac + $5/ac application cost = $60/ac

Table 3: Total grass hay yields in tons per acre (Least Squares Means) for each fertilizer treatment at the Larry Vignaroli Ranch along lower Clear Creek, northern Johnson County for June and fall harvests 2007 – 2009.

	Fertilizer Treatments			
Grasses	Control	N1	N2	N+P
June Harvests:				
Bozoisky Russian wildrye	5.8 b[1]	8.0 c	10.5 b	9.7 a
NewHy hybrid wheatgrass	8.4 a	9.5 bc	10.9 b	10.9 a
Luna pubescent wheatgrass	7.6 ab	11.0 ab	10.9 b	12.9 a
Mandan pubescent wheatgrass	7.4 ab	12.0 ab	10.3 b	13.8 a
Manchar smooth bromegrass	8.2 a	12.1 a	14.7 a	14.0 a
Regar meadow bromegrass	8.1 a	12.0 ab	13.2 ab	14.8 a
Average	*7.6 D*[2]	*11.0 B*	*12.1 AB*	*12.9 A*
Fall Harvests:				
Bozoisky Russian wildrye	2.5 a	3.0 ab	4.0 a	2.5 abc
NewHy hybrid wheatgrass	2.4 a	3.7 a	5.9 a	4.6 a
Luna pubescent wheatgrass	1.7 b	2.5 bc	4.1 a	2.3 c
Mandan pubescent wheatgrass	1.9 b	1.8 c	5.0 a	2.5 bc
Manchar smooth bromegrass	2.6 a	3.1 ab	5.6 a	3.4 abc
Regar meadow bromegrass	2.6 a	3.8 a	5.3 a	4.0 ab
Average	*2.3 C*	*3.1 B*	*4.9 A*	*3.2 B*
Total for June & Fall:				
Bozoisky Russian wildrye	8.4 b	10.9 c	14.1 b	11.4 a
NewHy hybrid wheatgrass	10.8 a	13.1 bc	16.1 ab	14.6 a
Luna pubescent wheatgrass	9.2 ab	13.1 bc	15.0 b	15.5 a
Mandan pubescent wheatgrass	9.6 ab	12.7 bc	16.6 ab	16.6 a
Manchar smooth bromegrass	10.1 ab	15.2 ab	20.3 a	18.9 a
Regar meadow bromegrass	10.7 ab	15.7 a	18.5 ab	18.8 a
Average	*9.8 C*	*13.8 B*	*17.3 A*	*16.2 A*

[1]Grass hay yield means within a fertilizer treatment for each hay harvest and total followed by the same small letter are not significantly different at the 0.05 level of probability.

[2]Grass hay yield average means across fertilizer treatments for each hay harvest and total followed by the same capital letter are not significantly different at the 0.05 level of probability.

Table 4: Grass hay total net income ($/acre) after fertilizer costs[1] for each fertilizer treatment at the Larry Vignaroli Ranch along lower Clear Creek, northern Johnson County for June and fall harvests 2007 – 2009.

	Fertilizer Treatments			
Grasses	Control	N1	N2	N+P
June Harvests:				
Bozoisky Russian wildrye	552	552	740	722
NewHy hybrid wheatgrass	785	752	818	721
Luna pubescent wheatgrass	716	843	817	800
Mandan pubescent wheatgrass	684	1021	801	876
Manchar smooth bromegrass	759	929	1166	1046
Regar meadow bromegrass	754	900	1032	1090
Fall Harvests:				
Bozoisky Russian wildrye	241	282	169	271
NewHy hybrid wheatgrass	232	346	317	402
Luna pubescent wheatgrass	152	213	169	203
Mandan pubescent wheatgrass	180	190	196	225
Manchar smooth bromegrass	232	293	307	333
Regar meadow bromegrass	235	342	281	362
Total for June & Fall:				
Bozoisky Russian wildrye	793	834	909	992
NewHy hybrid wheatgrass	1017	1099	1134	1123
Luna pubescent wheatgrass	868	1056	986	1003
Mandan pubescent wheatgrass	864	1211	997	1101
Manchar smooth bromegrass	991	1223	1473	1379
Regar meadow bromegrass	989	1242	1313	1451

[1]Grass hay prices: $109, $100, and $70/T for 2007, 2008, and 2009, respectively from USDA-WY Dept Ag Market News, Torrington, WY

Fertilizer costs: Control (June and Fall Harvests) - No fertilizer and application costs;
N1 and N2 (June) - $61, $86, and $60/acre for 2007, 2008, and 2009, respectively;
N+P (June) - $79, $86, and $108/acre for 2007, 2008, and 2009, respectively;
N1 and N+P (Fall) - No fertilizer and application costs;
N2 (Fall) - $61, $86, and $60/acre for 2007, 2008, and 2009, respectively

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