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Cool-season Perennial Grasses for Spring Grazing

Nine cool-season perennial grasses planted into four 12' x 200' replicated plots in May 2003 at Ray Daly's along lower Piney Creek in southern Sheridan County underwent a series of harvests in 2005, 2006, and 2007 to determine their potential for use as spring pasture. The nine grasses were Bozoisky-select Russian wildrye (RWR), Hycrest crested wheatgrass (CWG), Luna and Mandan pubescent wheatgrass (PWG), NewHy hybrid wheatgrass (HWG), Critana thickspike wheatgrass (TWG), Rosana western wheatgrass (WWG), Manchar smooth bromegrass (SBG), and Regar meadow bromegrass (MBG). Critana TWG and Rosana WWG are native grasses and NewHy HWG is a cross between quackgrass an introduced species and bluebunch wheatgrass a native species, the other six grasses are introduced species. The grasses were hayed in late June all three years and summer regrowth was grazed by cattle over the winter leaving little residual forage in the spring of the year.

Leaves, and stems when present, of each grass were harvested from a randomly placed 0.25 m^2 (2.7 ft^2) hoop weekly between 26 April and 31 May in 2005 and 2006, and between 3 May and 31 May in 2007 to determine initial growth forage amounts. The week delay in the first sampling in 2007 was due to cool April temperatures (Table 1a), especially daily maximums, that slowed early spring grass growth. After clipping the grasses a wire colored flag (color indicating initial clipping date) was inserted into the ground in the middle of the hoop. Two weeks following each initial growth harvest regrowth of the grasses was sampled, except in 2006 following a 31 May initial harvest due to the dry conditions. In addition, two weeks following each first regrowth harvest, second regrowth of the grasses was harvested, except in 2006 following a 7 June first regrowth harvest again due to dry conditions. In 2005 and 2006 grass growth and regrowth were harvested to a two to three inch stubble height (measured from soil surface), except growth on 24 and 31 May was harvested to a four to

five inch stubble height. However in 2007, grass growth and regrowth harvest heights were adjusted to represent stubble heights that would be left following a grazing event (Table 2). Well managed grazing would leave a sufficient stubble height to enhance regrowth. Leaf heights at time of harvest were also recorded in 2007 (Table 2), and leaf growth stage was noted on 3 and 10 May.

Harvested grass material was dried and amounts reported are on a dry matter basis. An analysis of variance was performed on yield data for each harvest date to determine if differences among grasses and between years was significant at the 0.05 level of probability.

Results and Discussion

Initial Growth

Between 26 April and 17 May 2005 and 2006 and between 3 and 17 May 2007 Bozoisky RWR produced the most initial growth averaging 855 lb/ac and Rosana WWG the least at an average of 305 lb/ac (Table 3 and Figure 1). Crested wheatgrass generally is considered to be one of the earliest producers of grazable forage but in this study Bozoisky RWR out-yielded Hycrest CWG by an average of 300 lb/ac between 26 April and 17 May over the three years.

In mid-May initial growth of the grasses accelerated producing an average of three times more forage on 31 May compared to on 17 May (Table 3 and Figure 1). By late May grass phenological growth stage ranged from stem elongation for Rosana WWG, in boot (seed head encased in stem) for Luna and Mandan PWG, and NewHy HWG, seed heads emerging for Critana TWG and Hycrest CWG, to seed heads emerged for Bozoisky RWR, Manchar SBG, and Regar MBG. Although the two bromes appeared to have slower growth rates in early May compared to Bozoisky and Hycrest they surpassed them in the latter half of the month.

Regar MBG, Manchar SBG, and Bozoisky RWR produced the most initial growth between 26 April and 31 May over the three years at an average of 1260 lb/ac followed by Hycrest CWG at 1050 lb/ac (Table 3 and Figure 1). Critana TWG, Luna and Mandan PWG, and NewHy HWG produced similar amounts of initial growth at an average of 880 lb/ac and Rosana WWG produced the least at an average of 520 lb/ac.

Except possibly for Bozoisky RWR, grass initial growth by early May was not sufficient to support grazing. However, by the second week of May most of the grasses, except for Rosana WWG, had enough growth to sustain managed grazing. In 2007, none of the grasses were beyond the 3-leaf stage on 3 May but by 10 May all the grasses were at the 4-leaf stage, except Rosana WWG which was at the 3-leaf stage. Removal of grass leaf material prior to the three-leaf stage reduces photosynthetic capacity of the grass at a time when carbohydrate reserves are low resulting in reduced subsequent growth (Coyne et al 1995, Manske 1994). Leaf height of the grasses in 2007 at the 3-leaf stage averaged six inches and at the 4-leaf stage eight inches. Irrigated pasture studies at North Platte, Nebraska found that forage yields of meadow bromegrass, smooth bromegrass, orchard-grass, and creeping foxtail were enhanced if they were not defoliated until they reached a leaf height of at least six inches (Volesky and Anderson 2007, Volesky and Clark 2003).

First Regrowth

Regrowth two weeks after a 26 April and a 3 May initial clipping averaged 550 lb/ac for Bozoisky RWR, Hycrest CWG, Manchar SBG, and Regar MBG; 465 lb/ac for Luna and Mandan PWG, and NewHy HWG; and 340 lb/ac for Critana TWG and Rosana WWG

over the three years of the study (Table 4 and Figure 2). However, average regrowth yield of the grasses on 17 May 2005 and 2006 was nearly twice as much as that on 10 May. Thus, if the grasses were grazed in late April a longer rest period than two weeks should probably be applied. Grass leaf heights on 17 May 2007 ranged from 6.5 inches for Critana TWG and Rosana WWG to 10.5 inches for Bozoisky RWR and Mandan PWG heights sufficient to support grazing (Table 2). Most likely grass leaf heights on 17 May in 2005 and 2006 were comparable.

Regrowth of the grasses was similar two weeks after an initial clipping on 10 and 17 May averaging 925 and 955 lb/ac, respectively, over the three years (Table 4 and Figure 2). Delaying initial harvest until these dates generally resulted in twice as much regrowth over the three years compared to when initial defoliations occurred on 26 April and 3 May. The amount of regrowth harvested from the grasses on 24 and 31 May was greatest for Regar MBG and Manchar SBG at a three year average of 1280 lb/ac followed by Luna and Mandan PWG at 1060 lb/ac. Critana TWG and Rosana WWG had the least amount of regrowth for this period averaging 670 lb/ac.

Regar MBG also produced the most regrowth two weeks after initial clippings on 24 and 31 May with a three year average of 1005 lb/ac and Manchar SBG yielded only a little more than half that of Regar (Table 4 and Figure 2). Luna and Mandan PWG produced similar amounts of regrowth as Regar MBG at averages of 910 and 985 lb/ac, respectively. In addition, regrowth of Bozoisky RWR was consistent following these initial clipping dates averaging 705 lb/ac, whereas Hycrest CWG regrew poorly producing an average of 260 lb/ac.

Regar MBG and Mandan PWG produced the most first regrowth when averaged over all two-week regrowth periods over the three years at 955 and 810 lb/ac, respectively (Table 4 and Figure 2). Manchar SBG and Luna PWG produced an average of 765 lb/ac of regrowth, Bozoisky RWR 670 lb/ac and the other four grasses an average of 575 lb/ac.

Second Regrowth

Manchar SBG and Mandan PWG produced the most second regrowth two weeks after a 10 and 17 May first regrowth harvest at an average of 1060 lb/ac over the three years followed by Luna PWG and Regar MBG at an average of 940 lb/ac; the other five grasses produced an average of 685 lb/ac (Table 5 and Figure 3). Luna and Mandan PWG and Regar MBG also produced the most second regrowth two weeks after a 24 May first regrowth clipping at an average of 960 lb/ac. Regrowth of Manchar SBG for this two week period averaged 700 lb/ac, 40 lb/ac less than that for Critana TWG and Rosana WWG.

Regrowth of all the grasses was less following a 31 May and 7 June first regrowth harvest compared to the above dates with Regar MBG producing the most at an average of 815 lb/ac (Table 5 and Figure 3). Bozoisky RWR, Critana TWG, Luna and Mandan PWG, and Rosana WWG yielded an average of 555 lb/ac following these latter first regrowth clipping dates and Manchar SBG and NewHy HWG averaged 340 lb/ac, with Hycrest CWG producing the least at 125 lb/ac. The most notable difference in the amount of regrowth produced among the grasses was the nearly three times less yielded by the two pubescent wheatgrasses after a 7 June first regrowth clipping compared to a 31 May harvest.

The two pubescent wheatgrasses are later in their maturity compared to the other grasses in this study, except for the two native grasses, and this is probably why they were

able to produce a significant amount of regrowth following a second defoliation, except after a 7 June first regrowth harvest (Figure 3). Their growing points were possibly still near the soil surface and thus not removed on the initial and first regrowth clippings. This was also probably true for the two native grasses. However, this does not necessarily explain the regrowth production exhibited by Regar MBG. This grass is comparable in its growth stages to Manchar SBG but unlike Manchar its second regrowth did not significantly decline with later first regrowth harvests.

Regar MBG, and Luna and Mandan PWG produced the highest amount of second regrowth over all two-week regrowth periods over the three years at an average of 845 lb/ac followed by Manchar SBG at 700 lb/ac (Table 5 and Figure 3). Bozoisky RWR, Critana TWG, NewHy HWG, and Rosana WWG produced an average of 610 lb/ac of second regrowth with Hycrest CWG producing the least at an average of 365 lb/ac.

Total Forage Yields

When initial growth is added to first and second regrowth for each clipping series and averaged across the series Regar MBG produced the most forage each year with a three year average of 3240 lb/ac (Tables 3, 4 and 5). Manchar SBG, Luna and Mandan PWG, and Bozoisky RWR produced similar amounts at an average of 2620 lb/ac across clipping series over the three years. The remaining four grasses produced an average of 2005 lb/ac of total forage.

Initial Growth by Year

Grass growth on 3 and 10 May averaged 255 lb/ac more in 2006 compared to in 2005 and 2007 (Figure 4), whereas on 24 and 31 May it averaged 875 and 1545 lb/ac more in 2005 compared to 2006 and 2007, respectively. April maximum temperatures recorded at the Johnson County Airport (Buffalo) and at Clearmont 5 SW averaged 61° in 2006 compared to 56° and 53° in 2005 and 2007, respectively (Table 1a; min temperatures were similar). Warmer daytime highs would explain the greater growth of the grasses from inception of growth into early May in 2006 compared to in 2005 and 2007.

Although daily high temperatures the first half of May 2006 averaged over 4° higher compared to in 2005, April through mid-May precipitation in 2005 totaled over six inches compared to less than 1.5 inches in 2006 (Tables 1a and 1b). Thus the significant spring moisture in 2005 compared to the dry, warm conditions in 2006 (irrigation did not occur until early June) would explain the differences in grass growth between mid- and late May these two years (Figure 4). In addition, 100 lb per acre of nitrogen (N) fertilizer was applied on 19 April 2005, whereas in 2006 it was not applied until 19 May. This delay in N fertilization also probably attributed to this difference in grass production between the two years. However, why grass growth between mid- and late May 2007 was generally less than in 2006 is not clear, especially when May 2007 precipitation in the area was around four inches.

Mid- to end of May daily temperatures averaged 53° in 2007 compared to 62° in 2006 which would possibly explain the greater growth in 2006 even under drier conditions (Figure 4). However, 2005 temperatures were similar to those in 2007 but grass growth as reported above was substantial during this period in 2005. In addition, N at 100 lb/ac was applied on 9 May 2007, 10 days earlier than in 2006 but 20 days later than in 2005. Thus it would have been assumed that grass growth between mid- and late May 2007 should have been greater compared to in 2006. Although it probably did not reduce the amount of growth

harvested by a significant amount, clipping at a higher stubble height in 2007 compared to 2006 might partially explain the lower yields for this period in 2007.

First Regrowth by Year

As with growth, regrowth of the grasses in early May was greater in 2006 compared to 2005 due to the warmer April and early May temperatures in 2006 (Figure 5 and Tables 1a and 1b). Regrowth of the grasses following a 10 and 17 May initial defoliation was significantly greater in 2005 compared to 2006 and 2007 due most likely to the amount of late April and May precipitation in 2005 and possibly timing of nitrogen fertilization. The warm conditions in April and May 2006 resulted in regrowth being highest on 24 May but declined thereafter due most likely to the dry conditions. Whereas in 2007 first regrowth was highest on 7 June and only slightly lower on 14 June. This might be explained in part due to the possibility that the plot area received two or more inches of precipitation during the first week of June. A Community Collaborative Rain, Hail & Snow Network station located 6.4 miles WNW of the plots received three inches of precipitation the first week of June 2007. However, why May regrowth was less in 2007 compared to in 2005 and 2006 is not known, especially when April and May precipitation and temperatures were near or above average.

Why two-week regrowth following a 24 or 31 May initial harvest was half that compared to after a 10 or 17 May harvest in 2005 was possibly due to the grasses having their growing points elevated (stem development) and removed when clipped on the latter two dates thus causing regrowth to have to initiate from dormant basal buds (Figure 5). When grasses are in what is known as the vegetative stage (leaves, no stems and growing point at or below the soil surface) regrowth occurs from the base of the existing leaves. Thus, other than a complete removal of a leaf by a grazing animal growth of grazed leaves does not stop. The limiting factors for regrowth are available moisture and temperature. However, as noted above, 2007 grass regrowth harvested on 7 and 14 June was greater than that harvested on 24 and 31 May. A possible reason for this was that the grasses were not harvested as close to the ground in 2007 as in 2005. Though the grasses were in similar physiological growth stages both years there was probably more leaf material present in 2007 to provide energy to the new shoot as it broke dormancy and began growth resulting in a quicker recovery.

Second Regrowth by Year

Due to the significant amount of May moisture the area received in 2005 second regrowth of the grasses following a 10 and 17 May first regrowth harvest was twice as in 2005 compared to 2006 and 2007 (Figure 6 and Tables 1a and 1b). Timing of nitrogen fertilization in 2005 compared to the other two years, especially in 2006, probably also contributed to this difference. The higher average second regrowth on 14 and 21 June in 2007 was probably due to the area possibly receiving two or more inches of precipitation during the first week of June as noted above in the first regrowth by year discussion.

Management Implications

Grazing initial growth of these grasses should probably not occur until the second week of May, except for Bozoisky RWR which could possibly begin the first week of May and Rosana WWG which probably should not begin until the third week of May. It also needs to be remembered that the most detrimental phenological growth stage for grasses to be defoliated in, whether by grazing or mowing, is in boot to anthesis (flowering), thus it is recommended to avoid delaying the start of grazing of these grasses,

except for Rosana WWG, until late May. Besides the potential for a reduction in the health and vigor of the grasses by delaying grazing until late May it could also result in a significant loss in forage through trampling by the livestock. However, if the pasture is divided into paddocks and a well managed grazing rotation is implemented the delay in grazing of some paddocks should not be a concern. There still will be a loss in forage through trampling but physiological damage to the plants will be at a minimum if the late initial May grazing does not occur in the same paddocks in subsequent years.

The greatest challenge in managing grazing of these grasses is not stocking to heavily in early May and too lightly in late May. If stocked too heavily in early May livestock will basically be chasing green and full production potential of the pasture will not be realized. In addition, stand longevity could be reduced opening the pasture up to invasion of non-desirable plants. Too light of stocking in late May will result in a waste of feed and possibly lower quality forage. The ideal situation is to keep the grasses in a vegetative stage (leaves and few stems) as long as possible which means using management intensive grazing (flexible grazing and rest periods).

Although the grasses were provided only a two week period to regrow after an initial growth and a first regrowth harvest rotating livestock through paddocks on such a time frame would not necessarily be advised. If initial grazing begins the second week of May and the grazing period is no longer than a week and the rest period could be no more than a couple of weeks. However, paddocks that are not rotated into until the latter part of May should probably receive three or four weeks of rest before grazing is allowed to occur again. In addition, paddocks that receive a second grazing should probably also receive at least four weeks rests before they are grazed a third time. This is just a guideline as growing conditions and stocking rates will determine how fast livestock can be moved through the paddocks.

Because of the differences in growth and regrowth rates among these grasses it may not be advisable to plant them in a mixture, especially if some type of a grazing rotation is not implemented. However, although it might complicate grazing management planting a few of these grasses in separate pastures could enhance livestock production. For example, Bozoisky Russian wildrye for earliest grazing followed by either Manchar smooth brome or Regar meadow brome then Luna or Mandan pubescent wheatgrass. If only one grass is to be planted Regar meadow brome would be recommended, especially if grazing is to occur from early May to late June.

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Table 1a: Monthly maximum and minimum temperatures (°F), and precipitation (in.) at Johnson County Airport – Buffalo and at Clearmont 5 SW in April, May, and June 2005, 2006, and 2007.

Johnson County Airport – Buffalo (14 miles S of study site):

	Maximum temperatures			Minimum temperatures			Precipitation		
Year	April	May	June	April	May	June	April	May	June
2005	54.5	60.3	73.5	31.5	38.8	52.3	2.15	6.39	2.99
2006	58.9	68.1	79.8	33.5	41.5	48.7	0.47	1.01	1.01
2007	50.8	65.8	75.1	31.5	31.7	45.4	1.33	3.64	2.12

Clearmont 5 SW (12 miles E of study site:

	Maximum temperatures			Minimum temperatures			Precipitation		
Year	April	May	June	April	May	June	April	May	June
2005	58.2	63.1	76.7	30.3	37.7	47.3	2.95	4.19	1.34
2006	62.6	69.8	82.9	32.3	38.7	47.9	0.98	1.34	1.10
2007	55.8	68.2	78.3	30.8	40.8	47.6	1.04	5.57	2.10

Table 1b: Daily maximum and minimum temperatures (°F), and precipitation (in.) at Johnson County Airport – Buffalo for the month of May 2005, 2006, and 2007.

	Maximum temperatures			Minimum temperatures			Precipitation		
Day	2005	2006	2007	2005	2006	2007	2005	2006	2007
1	36	61	78	21	38	46	0	0	0
2	47	56	77	17	34	50	0	0	0.02
3	59	48	74	25	30	37	0	0	0.49
4	64	42	55	38	31	35	0	0	0.15
5	67	62	42	42	25	35	0	0	1.26
6	76	71	52	50	38	36	0	0	0.13
7	58	64	63	43	46	35	1.38	0	0
8	51	52	69	42	40	42	0.21	0.19	0
9	51	45	76	41	30	47	0.36	0.13	0
10	51	49	78	43	28	48	2.21	0.02	0
11	43	64	74	24	30	47	1.37	0	0
12	30	73	87	24	43	52	0.03	0	0
13	60	65	82	42	41	48	0	0	0
14	59	68	51	39	38	39	0	0	0
15	72	71	61	42	40	35	0	0	0
16	73	78	9	52	42	42	0.02	0	0
17	68	81	81	45	49	47	0	0	0
18	69	84	80	39	54	51	0	0	0.37
19	80	82	79	49	54	50	0	0.02	0
20	83	82	67	49	50	51	0	0.28	0.01
21	65	85	60	44	49	44	0	0	0.22
22	75	87	48	41	53	36	0	0.02	0.13
23	63	67	54	47	52	36	0	0.35	0.03
24	61	72	63	40	48	33	0.15	0	0
25	58	83	53	38	49	36	0.01	0	0.02
26	60	83	63	34	52	31	0	0	0
27	65	68	75	40	46	42	0	0	0
28	67	72	66	41	43	45	0	0	0.17
29	51	63	53	39	38	41	0.06	0	0.05
30	47	63	57	38	37	39	0.59	0	0
31	60	70	53	35	40	38	0	0	0.59

Table 2: Leaf and stubble heights (inches) of the grasses on each initial growth harvest, and first and second regrowth harvest dates in 2007.

Growth	3 May		10 May		17 May		24 May		31 May	
Grasses[1]	Leaf	Stubble	Leaf	Stubble	Leaf	Stubble	Leaf	Stubble	Leaf	Stubble
Bozoisky	7.0	3.0	9.0	4.0	17.5	5.0	21.8	6.0	26.3	7.0
Hycrest	6.5	3.0	7.5	3.5	10.5	3.5	12.3	4.5	15.0	5.0
Luna	5.5	2.5	8.0	3.5	11.0	3.5	14.3	5.0	16.3	5.0
Mandan	6.0	2.5	8.3	4.0	12.3	4.0	15.3	5.0	18.5	5.5
NewHy	6.0	2.5	7.8	3.5	9.3	3.5	14.0	5.0	16.0	5.0
Critana	4.3	2.0	5.7	3.0	7.0	3.0	9.0	4.0	12.0	4.0
Rosana	4.3	2.0	6.0	3.0	8.0	3.0	9.3	4.0	9.7	4.0
Manchar	6.5	3.0	9.3	4.0	11.5	4.0	15.8	5.0	17.3	5.5
Regar	5.8	2.5	8.8	4.0	13.3	4.0	17.3	5.5	21.8	6.5

1st Regrowth	17 May		24 May		31 May		7 June		14 June	
Bozoisky	10.5	5.0	11.5	3.5	11.4	4.0	15.6	6.5	18.0	6.5
Hycrest	8.3	4.0	9.7	3.0	9.0	3.0	10.6	5.0	12.8	5.0
Luna	9.0	4.5	11.7	3.5	13.4	4.5	15.5	6.5	19.5	6.5
Mandan	10.5	5.0	13.0	4.0	14.9	5.5	18.3	7.0	20.8	7.0
NewHy	9.8	4.5	11.3	3.5	10.8	4.0	13.9	6.0	16.0	5.5
Critana	6.3	3.0	8.1	3.0	9.1	3.0	10.0	5.0	13.0	5.0
Rosana	6.7	3.0	8.1	3.0	10.4	3.5	11.5	5.0	13.3	5.0
Manchar	9.5	4.5	14.6	4.0	16.8	6.0	17.2	7.0	17.8	6.0
Regar	10.0	5.0	12.2	3.5	14.9	5.5	18.7	7.0	21.3	7.0

2nd Regrowth	31 May		14 June		21 June					
Bozoisky	10.2	4.0	12.8	4.5	25.0	6.5				
Hycrest	9.2	3.5	12.9	4.5	19.2	5.5				
Luna	11.5	5.0	19.0	6.5	26.0	6.5				
Mandan	13.5	6.0	19.5	6.5	26.2	6.5				
NewHy	11.7	5.0	14.9	5.0	18.7	5.0				
Critana	8.2	3.0	11.2	4.0	17.0	5.0				
Rosana	8.8	3.0	12.7	4.5	16.3	5.0				
Manchar	13.1	6.0	20.9	7.0	26.7	7.0				
Regar	12.8	6.0	21.4	7.0	28.8	7.0				

[1]Grasses: Bozoisky Russian wildrye; Hycrest crested wheatgrass; Luna and Mandan pubescent wheatgrass; NewHy hybrid wheatgrass; Critana thickspike wheatgrass; Rosana western wheatgrass; Manchar smooth bromegrass; and Regar meadow bromegrass.

Table 3: Initial grass growth dry matter yields (pounds per acre) at Ray Daly's between 26 April and 31 May in 2005, 2006 and 2007.

2005	*26 April*	*3 May*	*10 May*	*17 May*	*24 May*	*31 May*
Variety & Species[1]						
Bozoisky RWR	489 a[2]	765 a	1237 a	1329 a	1778 cde	3274 bc
Hycrest CWG	270 ab	304 bc	532 b	856 b	3030 a	3347 bc
Luna PWG	243 abc	308 bc	344 bcd	742 bc	2018 bcd	3261 bc
Mandan PWG	169 bc	324 b	358 bcd	674 bc	1934 cd	3738 ab
NewHy HWG	153 bc	182 cd	316 cd	622 bc	1462 def	3309 bc
Critana TWG	246 abc	272 bcd	526 bc	884 b	1125 ef	3328 bc
Rosana WWG	80 c	133 d	221 d	364 c	898 f	1861 c
Manchar SBG	236 abc	276 bcd	463 bc	893 b	2724 ab	5222 a
Regar MBG	213 bc	260 bcd	498 bc	824 b	2254 bc	4387 ab
2006	*26 April*	*3 May*	*10 May*	*17 May*	*24 May*	*31 May*
Bozoisky RWR	613 a	824 a	810 ab	1153 ab	1925 ab	2147 bcd
Hycrest CWG	422 b	627 ab	683 abc	812 bcd	1484 bc	1985 cd
Luna PWG	402 b	485 b	562 bc	742 cd	1263 bc	1836 cd
Mandan PWG	428 b	513 b	570 bc	808 bcd	1255 bc	2078 bcd
NewHy HWG	467 ab	499 b	808 ab	845 abcd	1386 bc	2583 abc
Critana TWG	386 bc	761 ab	607 abc	615 d	1260 bc	1680 cd
Rosana WWG	195 c	408 b	350 c	636 d	729 c	1228 d
Manchar SBG	430 b	639 ab	784 ab	1067 abc	1490 bc	3516 a
Regar MBG	432 b	731 ab	922 a	1202 a	2366 a	3095 ab
2007		*3 May*	*10 May*	*17 May*	*24 May*	*31 May*
Bozoisky RWR		504 a	607 a	1058 ab	1237 b	1472 b
Hycrest CWG		374 ab	460 abc	739 bc	1147 bc	1514 b
Luna PWG		270 b	303 c	607 c	748 cd	1210 bc
Mandan PWG		383 ab	377 bc	637 c	943 bcd	1435 b
NewHy HWG		334 ab	360 bc	597 c	820 cd	1216 bc
Critana TWG		273 b	270 c	543 c	558 d	1055 bc
Rosana WWG		196 b	226 c	559 c	520 d	590 c
Manchar SBG		338 ab	650 a	802 bc	1076 bc	1587 ab
Regar MBG		383 ab	546 ab	1243 a	1829 a	2337 a

[1]Grass species: RWR – Russian wildrye; CWG – crested wheatgrass; PWG – pubescent wheatgrass; HWG – hybrid wheatgrass; TWG – thickspike wheatgrass; WWG – western wheatgrass; SBG – smooth bromegrass; and MBG – meadow bromegrass

[2]Grass means within a date for each year followed by the same small letter are not significantly different at the 0.05 level of probability.

Table 4: Grass first regrowth, two weeks after an initial growth harvest, dry matter yields (pounds per acre) at Ray Daly's between 10 May and 14 June in 2005, 2006 and 2007.

	Regrowth Periods					
Grasses	*26 Apr to 10 May*	*3 to 17 May*	*10 to 24 May*	*17 to 31 May*	*24 May to 7 Jun*	*31 May to 14 Jun*
2005						
Bozoisky RWR[1]	434 a[2]	1239 a	1303 ab	1064 cd	905 a	860 abc
Hycrest CWG	356 a	825 b	1231 ab	1360 cd	396 b	102 d
Luna PWG	264 ab	753 bc	1513 ab	1733 abc	952 a	431 bcd
Mandan PWG	299 ab	697 bc	1355 ab	1714 abc	810 ab	613 abc
NewHy HWG	184 ab	557 cd	1332 ab	1380 bcd	680 ab	381 cd
Critana TWG	255 ab	506 cd	1188 ab	1302 cd	825 ab	978 ab
Rosana WWG	97 b	340 d	993 b	873 d	692 ab	1153 a
Manchar SBG	231 ab	843 ab	1541 a	2226 a	638 ab	0 d
Regar MBG	241 ab	695 bc	1689 a	2016 ab	825 ab	760 abc
2006						
Bozoisky RWR	438 a	591 a	563 cd	624 ab	586 b	
Hycrest CWG	478 a	701 a	890 abc	458 b	89 d	
Luna PWG	360 a	767 a	883 abc	747 ab	870 a	
Mandan PWG	413 a	683 a	1004 ab	1020 a	762 ab	
NewHy HWG	463 a	695 a	916 abc	655 ab	520 bc	
Critana TWG	382 a	625 a	433 d	453 b	522 bc	
Rosana WWG	315 a	554 a	634 bcd	612 ab	696 ab	
Manchar SBG	467 a	814 a	1170 a	1020 a	315 cd	
Regar MBG	482 a	756 a	1024 ab	867 ab	945 a	
2007						
Bozoisky RWR		612 a	576 cd	357 c	621 de	541 c
Hycrest CWG		432 abc	558 cd	360 c	395 e	317 c
Luna PWG		295 c	534 cd	671 bc	1051 bc	1240 ab
Mandan PWG		524 abc	673 bc	897 ab	1495 a	1242 ab
NewHy HWG		381 abc	485 cd	593 bc	841 bcd	589 c
Critana TWG		289 bc	357 d	384 c	477 de	668 c
Rosana WWG		253 c	340 d	451 c	742 cde	745 bc
Manchar SBG		470 abc	866 ab	861 ab	1095 bc	639 c
Regar MBG		598 ab	965 a	1142 a	1167 ab	1324 a

[1]Grasses: RWR – Russian wildrye; CWG – crested wheatgrass; PWG – pubescent wheatgrass; HWG – hybrid wheatgrass; TWG – thickspike wheatgrass; WWG – western wheatgrass; SBG – smooth bromegrass; and MBG – meadow bromegrass

[2]Grass means within a date for each year followed by the same small letter are not significantly different at the 0.05 level of probability.

Table 5: Grass second regrowth, two weeks after a first regrowth harvest, dry matter yields (pounds per acre) at Ray Daly's between 24 May and 21 June in 2005, 2006 and 2007.

	Regrowth Periods				
Grasses	*10 to 24 May*	*17 to 31 May*	*24 May to 7 Jun*	*31 May to 14 Jun*	*7 to 21 Jun*
2005					
Bozoisky RWR[1]	1166 ab[2]	1046 a	739 ab	531 abcd	545 ab
Hycrest CWG	1117 ab	1204 a	367 b	20 d	0 c
Luna PWG	1270 ab	1312 a	1149 a	848 ab	0 c
Mandan PWG	1095 b	1611 a	1040 a	484 abcd	182 bc
NewHy HWG	891 bc	1135 a	390 b	333 bcd	0 c
Critana TWG	871 bc	1111 a	1161 a	957 ab	639 ab
Rosana WWG	617 c	1138 a	978 a	757 abc	390 abc
Manchar SBG	1516 a	1400 a	533 b	194 cd	121 bc
Regar MBG	1122 ab	1294 a	902 a	991 a	728 a
2006					
Bozoisky RWR	520 abc	440 bc	562 b	340 b	
Hycrest CWG	242 c	216 c	132 c	80 c	
Luna PWG	746 a	779 ab	917 a	554 a	
Mandan PWG	665 ab	1058 a	966 a	584 a	
NewHy HWG	593 ab	726 ab	557 b	337 b	
Critana TWG	344 bc	477 bc	543 b	328 b	
Rosana WWG	388 bc	609 b	689 ab	417 ab	
Manchar SBG	825 a	779 ab	666 ab	403 ab	
Regar MBG	661 ab	697 b	712 ab	431 ab	
2007					
Bozoisky RWR		384 b	525 c	622 bcd	580 b
Hycrest CWG		451 b	362 c	258 d	273 c
Luna PWG		637 ab	863 b	1033 ab	547 b
Mandan PWG		839 a	927 ab	993 abc	380 bc
NewHy HWG		618 ab	584 c	594 cd	439 bc
Critana TWG		416 b	545 c	607 bcd	409 bc
Rosana WWG		407 b	538 c	613 bcd	534 bc
Manchar SBG		839 a	895 ab	520 d	476 bc
Regar MBG		908 a	1151 a	1076 a	857 a

[1]Grasses: RWR – Russian wildrye; CWG – crested wheatgrass; PWG – pubescent wheatgrass; HWG – hybrid wheatgrass; TWG – thickspike wheatgrass; WWG – western wheatgrass; SBG – smooth bromegrass; and MBG – meadow bromegrass

[2]Grass means within a date for each year followed by the same small letter are not significantly different at the 0.05 level of probability.

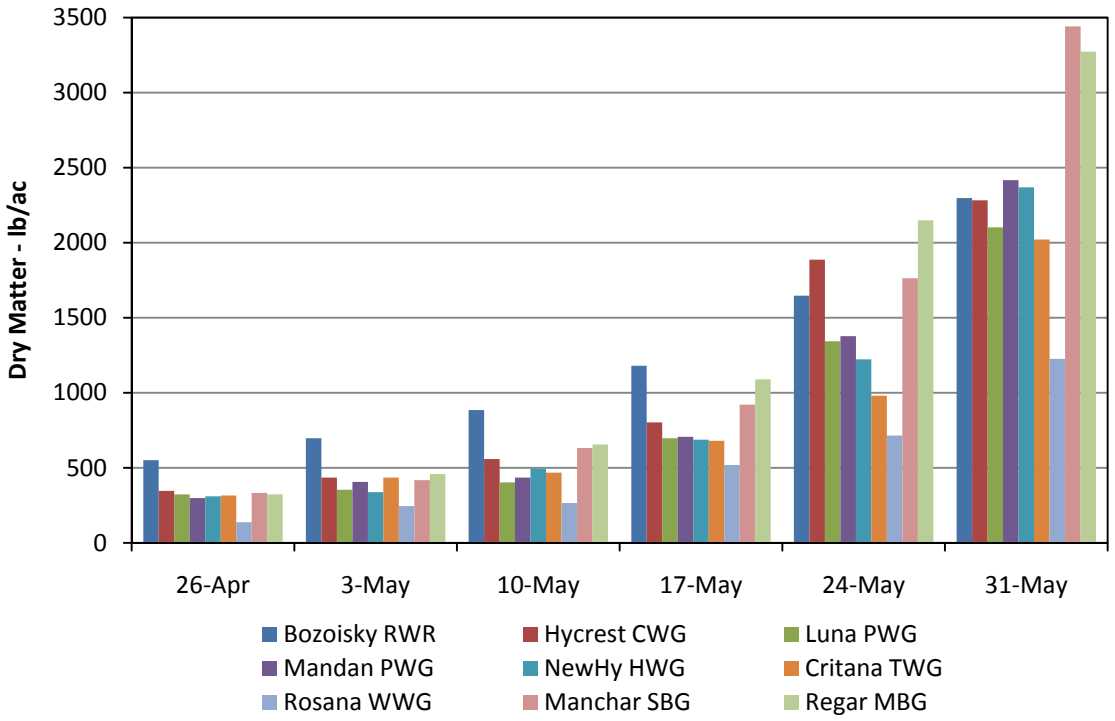

Figure 1: Initial growth of the cool-season grasses between 26 April and 31 May, averaged across 2005, 2006, and 2007, except 26 April averaged across 2005 and 2006.

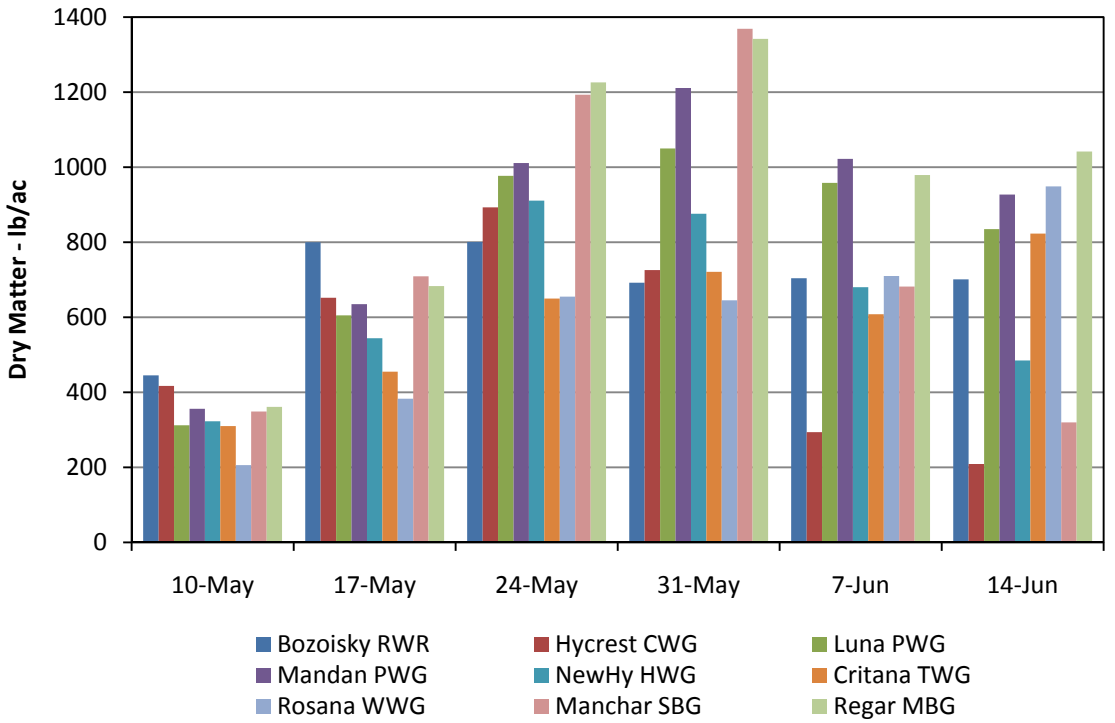

Figure 2: Regrowth of the cool-season grasses two weeks after an initial growth harvest, averaged across 2005, 2006, and 2007, except 10 May averaged across 2005 and 2006, and 14 June averaged across 2005 and 2007.

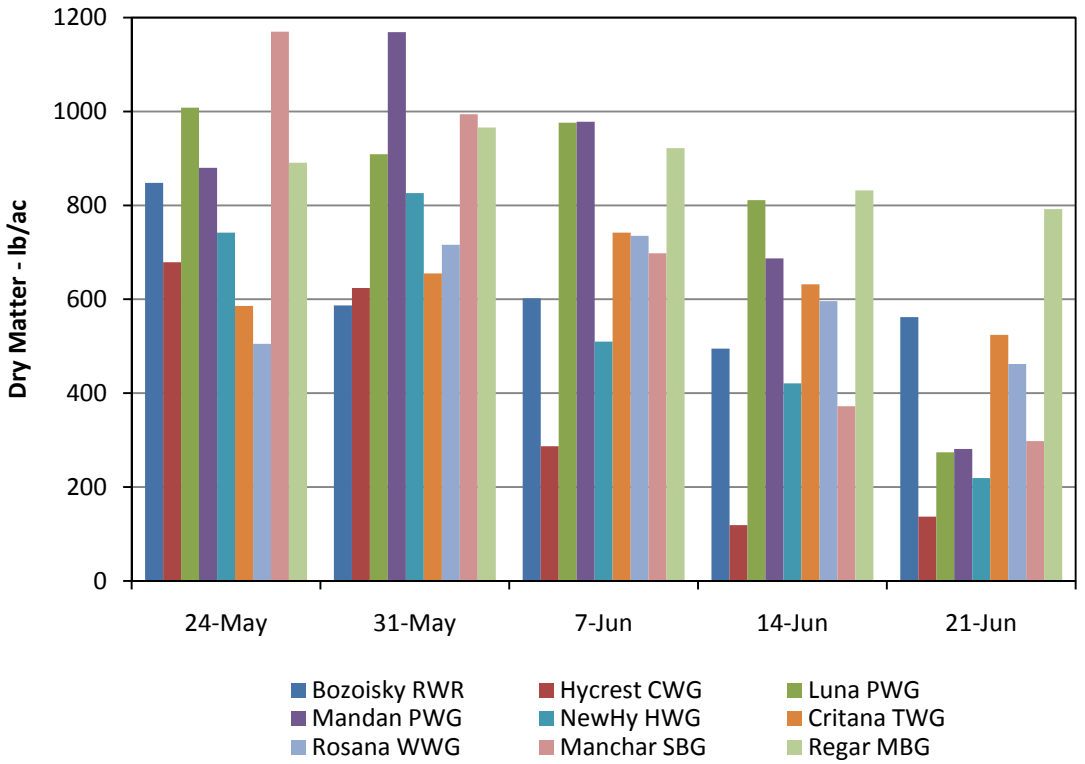

Figure 3: Regrowth of the cool-season grasses two weeks after a first regrowth harvest, averaged across 2005, 2006, and 2007, except 24 May averaged across 2005 and 2006, and 21 June averaged across 2005 and 2007.

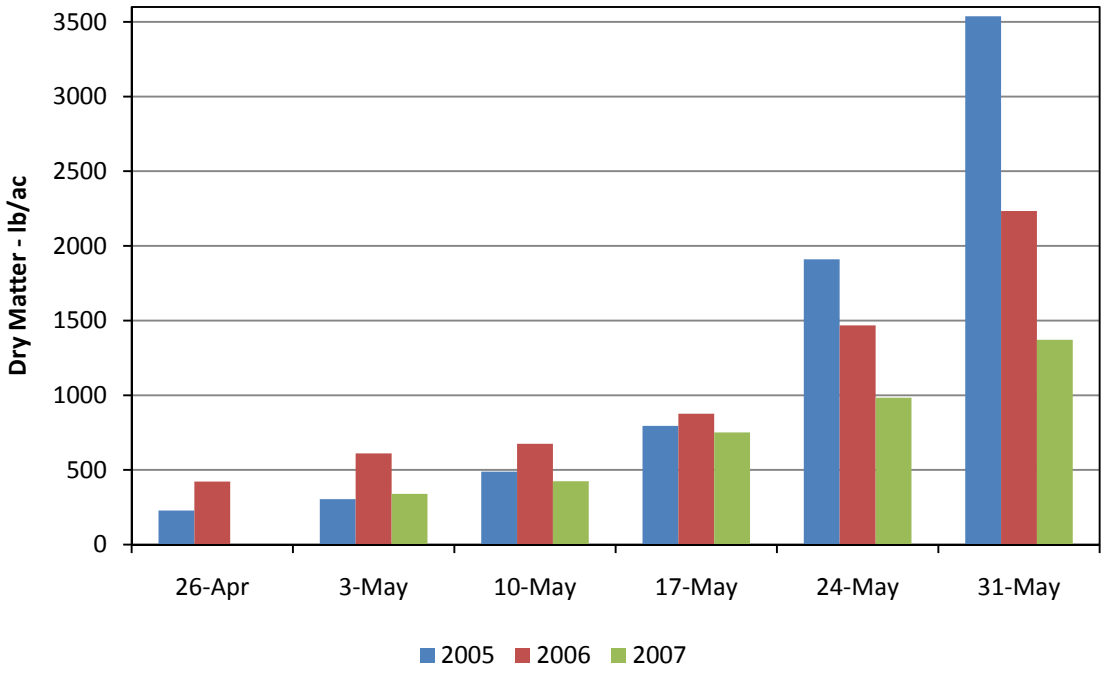

Figure 4: Grass initial growth in 2005, 2006, and 2007, averaged across the nine cool-season perennial grasses.

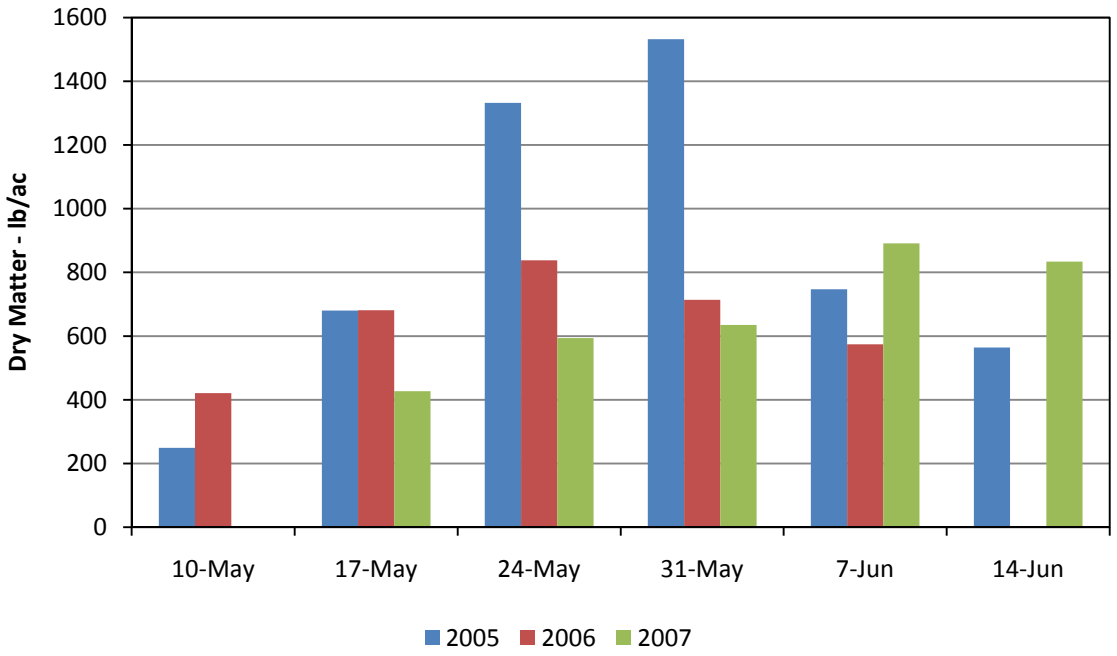

Figure 5: Grass regrowth two weeks after an initial harvest in 2005, 2006, and 2007, averaged across the nine cool-season perennial grasses.

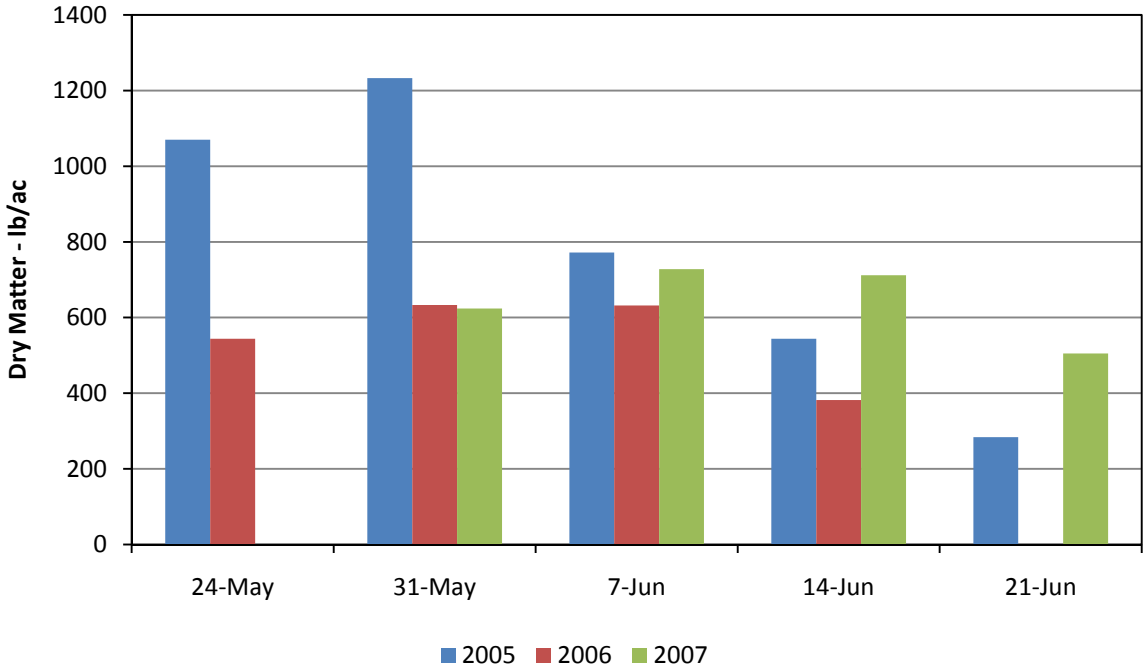

Figure 6: Grass regrowth two weeks after a first regrowth harvest in 2005, 2006, and 2007, averaged across the nine cool-season perennial grasses.

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