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Cooperative Extension

Northeast Colorado Forage Comparisons

D.B. Bosley, J.P. Schneekloth,
R.F. Meyer, E.G. Schmitz,
M.F. Vigil

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D. Bruce Bosley[1], Ron F. Meyer[1], Joel P. Schneekloth[2], Gene G. Schmitz[1], Merle F.Vigil[3]

A Cooperative Project

of the

Cooperative Extension
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[1] Area Extension Agent, Colorado State University Cooperative Extension
[2] Regional Water Resource Specialist, Colorado State University Cooperative Extension
[3] Research Leader, Central Great Plains Experiment Station; USDA-ARS

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Introduction

Crop and livestock producers in the Colorado High Plains have become increasingly interested in raising perennial and annual forages. Forages are considered an alternative to raising cash grain crops under irrigated, limited irrigation, and dryland farming systems. Forages can be harvested as hay or directly grazed by livestock. Once established, perennial forages have relatively low average annual input costs. Fertilizer, water, and harvesting costs are the primary material input and labor costs on irrigated and dryland forage fields. The use of annual forages can be a desirable alternative offering crop producers flexibility in their cropping systems. Research regarding available grass and legume forages is limited in the High Plains of Colorado, Kansas, Nebraska, and Wyoming. The purpose of these studies is to determine yield and quality of annual and perennial forages in order to help producers ascertain the suitability of forage cropping options for both irrigated and dryland production.

Irrigated Forages Study

D. Bruce Bosley, Joel P. Schneekloth, Gene Schmitz, Ron Meyer, and Merle Vigil

Methods and Methods

Forage trials were established in 2001 on the USDA Central Great Plains Research Station near Akron Colorado. Yield and forage quality comparisons were made during the growing seasons of 2002 and 2003.

Seventeen perennial and six annual forages were planted for yield and quality comparisons. The cool season perennial species *(cultivars)* tested in this study were; smooth bromegrass *(Lincoln)*, meadow bromegrass *(Regar)*, two prairie bromegrasses *(Matua, AGR BW101 (experimental))*, creeping foxtail *(Garrison)*, tall fescue *(Fuego)*, orchardgrass *(Latar)*, orchardgrass + alfalfa, orchardgrass + birdsfoot trefoil *(Norcen)*, orchardgrass + sainfoin *(renumex)*, annual ryegrass *(Italian)*, perennial ryegrass *(Herbie)*, hybrid wheatgrass *(Newhy)*, tall wheatgrass*(Jose)*, and pubescent wheatgrass *(Luna)*. Warm season perennials included: big bluestem*(Kaw)*, Eastern gamagrass, and switchgrass *(Nebraka 28)*. Annuals included: Oats *(Ogle)*, Triticale *(Trical 102 in 2003)*, Barley *(Otis 2002)*, Wheat *(Longhorn)*, Sorghum-sudan *(Sooner Sweet)*, and Foxtail Millet *(White Wonder)*. Seeding rates were intentionally set higher than normally recommended in order to insure the plant stand (Table 1).

All forages in the trial were watered with a solid set irrigation system. Scheduling of irrigation was done by the checkbook method with estimated crop water use obtained from a weather station at Akron and hand-feel method for determining soil moisture. Reference evapotranspiration (alfalfa) was multiplied by a coefficient of 0.85 to determine water use for irrigated grasses.

All forage selections were planted with a no-till cone metered drill. Perennials grasses were seeded at a rate of two ounces of seed per 5 foot by 50 foot plot. Perennial forages were planted in April 2001. An experimental perennial bromegrass was planted in April of 2002. Winter triticale and winter wheat were planted in late September of 2001 and 2002. Hybrid sorghum-sudan and pearl millet were planted in early June of 2002 and 2003. An orchardgrass/legume mixture was planted using three legumes: alfalfa, birdsfoot trefoil, and sainfoin. This was done to compare the grass/legume mixtures to orchardgrass alone and to the other single grass forages. The perennial and annual forage comparison study was planted in a randomized block design with four replications.

The winter and summer annuals were planted as a continuous cropping system. Sorghum-sudan and forage foxtail millet were planted into the harvested stubble of the winter triticale and winter wheat respectively. The continuous crop sequence was continued by planting the triticale and wheat into the sorghum-sudan and forage millet stubble respectively. Continuous cropping with annual forages completed two full cycles during the trial with the beginning of winter annual plantings in the fall of 2001 and finishing with the final harvest of the summer annual forages in September of 2003. Oats were planted in April of 2003 and harvested in June at the dough growth stage.

Forage harvest was accomplished using a Carter plot flail harvester. Each forage treatment was harvested near the boot stage of maturity. Forages were harvested to a stubble height of approximately four inches. Forage oats were harvested in late milk to early dough stage. Samples were taken to establish the moisture content of each forage plot at harvest for quality characteristics and sent to an independent laboratory for analysis. The lab reports included crude protein, acid detergent fiber, total digestible nutrients, net energy, calcium and phosphorus. Calcium and phosphorus levels are not reported in this publication but are available from the authors. Harvest intervals of the forages depended on regrowth and were typically between 25 and 30 days.

The 2001 growing season was used to establish the perennial forages and no harvest measurements were taken. Yield and quality measurements were taken throughout 2002 and 2003 with multiple harvests each season for nearly all of the cool season perennial grass and grass/legume treatments. Winter annuals were harvested only one time each year at the first forage harvest date. The hybrid sorghum-sudan plots were harvested three times during 2002 while the forage millet plots were harvested once in 2002 and 2003.

In the fall of 2001, nitrogen fertilizer (40 lbs/acre) was applied to half of each treatment block in a split plot design. Fertilizer was broadcast applied as ammonium nitrate (34-0-0). This was done to investigate nitrogen response of fall-applied fertilizer.

All treatment plots were fertilized equally after the initial 2002 harvest through the 2002 and 2003 production season. The total nitrogen applications for the 2002 harvest season included the fall 2001 40 lbs/acre and an additional 80 lbs/acre applied as well as 40 lbs/acre of phosphorus was applied in late May. A total of 250 lbs/A of nitrogen was applied in three split season applications to all plots in 2003.

Results and Discussion - 2002

Fall 2001 applied nitrogen increased yields in may of 2002 compared to check treatments where no fall nitrogen was applied (Figure 1). Fall fertilized cool season forage plots had greater stand height and density as compared to the unfertilized treatments. Total forage yields were significantly greater due to the application of 40 lbs of N. Fertilized yields were 3 to 4 times greater than yields of unfertilized treatments. A pale leaf color was noted across the plots in July and August of 2002. Consequently, it was decided to increase the rate and frequency of nitrogen applications in the 2003 season for all treatments.

A hailstorm in late August reduced forage yields in 2002. Total dry matter production for 2002 is shown in Figure 2. The greatest production was an annual system of triticale and sorghum-sudan. The annual system of winter triticale (2.3 tons/acre) and sorghum-sudan (3.5 tons per acre) resulted in a total season yield of 5.8 tons/acre of dry matter which was greater than any perennial system tested in 2002. The double crop winter wheat and forage millet treatment also produced significantly greater yields than any of the perennial treatments. Millet yield and quality did not match that of the sorghum-sudan treatment primarily because it was managed for a single cutting.

Tall fescue topped the yields of all perennial grasses with 4.5 tons/acre. Yields of the majority of the remainder of the cool season perennial grasses yielded between 3 and 4 tons/acre in 2002.

The addition of legumes into a grass mixture did not increase production as compared to a grass monoculture. The amount of legume in each of the plots was negligible during 2002 and 2003. Production of pure orchardgrass was similar to that of mixtures of orchardgrass with alfalfa, sainfoin or birdsfoot trefoil. Average yield of orchardgrass was 3.5 tons/acre compared to 3.6 tons/acre when a legume was added to the mixture.

Matua prairie brome, Italian annual ryegrass, and Garrison creeping foxtail did not perform well in this trial. Matua failed to fill the available groundcover and consequently had a high level of weeds present throughout the 2002 and 2003 season. Italian annual rye also failed to fully recover between the 2001 establishment season and subsequent years. Garrison creeping foxtail failed to establish. It does well in wet and poorly drained sites. These species may do very well in other settings but, under our management practices, they were not a good fit.

Warm season perennials were deemed too slow to establish for this trial. They were harvested at a time when the stands were not fully established even in the last year of the study. Switchgrass was harvested in the 2002 year and had the best productivity of the three warm season grasses in the trial.

Quality: Forage quality was estimated by measuring crude protein (CP) and acid detergent fiber (ADF). Indigestible fiber levels in forage plants increase as plants mature. ADF is a method to measure this indigestible fiber. Forage energy content is inversely related to the fiber content as measured by ADF. Therefore as ADF increases, the energy content of the forage decreases. The differences in ADF measured in this trial may be more indicative of proper timeliness of harvesting the plots than in real differences in the relative quality potential of the treatments. CP and energy levels of most of the cool-season perennial forages was adequate to support over 2.0 pounds of average daily gain for 600 pound stocker cattle or 30 pounds of daily milk production for 1,400 pound beef cows.

The addition of a legume did not increase the energy or protein content of the forage. Legumes were present after planting in 2001 but stands were found in 2002. The lack of increase of either yield or quality by addition of a legume may be due to the lack of legume persistence in the plots. This may have been caused by orchardgrass competitiveness, harvest management, or fertility management which favored the grasses.

Competitiveness: Each treatment was visually evaluated for its competitive ability against grassy and broad-leafed weeds. The following grasses were found the most competitive: orchardgrass, meadow brome, tall fescue, and perennial ryegrass. The annual small grains, sorghum-sudan, and foxtail millet were found competitive with annual weeds. Wheatgrasses were rated only moderately competitive with Newhi wheatgrass being the most competitive followed by Luna pubescent wheatgrass.

The warm season grasses (switchgrass, eastern gamagrass, and big bluestem) were very slow to establish and, consequently, poor competitors even after two years. Switchgrass establishment was greater than all other warm season perennials.

Matua bromegrass established well in 2001 but was a poor competitor to weeds and exhibited reduced vigor in 2002. The experimental bromegrass planted in 2002 established well in the test plots but failed to fill between the plants and was fair in weed competition.

Results and Discussion – 2003 and Two Year Summary

Yields in 2003 were generally greater for most forage treatments compared to 2002. The additional nitrogen fertilizer applied in 2003 and the absence of hail injury are attributed to increased yields in 2003. May and early June weather was cooler and wetter than average for Akron. However, temperatures in July and August were above normal. The 2003 precipitation for July, August, and September was less than average. Higher than average temperatures may have had some affect on the 2003 forage yield and quality. Forage production and quality are summarized in tables 2 through 5.

April plantings were made for oats and Italian annual ryegrass but only the oats established an adequate stand. Rodent predation destroyed all but one replicate of the sorghum-sudan hybrid planting. Field level plantings should not experience this level of rodent damage with the exception of field margins. Border strip vegetation mowing or other plant suppression and rodent control treatments could be made to minimize seeding losses.

Yield by cutting and total yield are shown in figure 3. The yield of the continuous crop system using triticale or another adapted winter annual grass and sorghum-sudan is expected to return the highest yield potential for irrigated production based upon the 2002 trial results. The winter triticale had similar yields to winter wheat. The yield advantage of sorghum-sudan can be expected whether single or multiple harvests are made during the season. Forage quality can be improved considerably with multiple cuttings.

The cool season perennials consistently outperformed the three warm season grasses in this trial. Two exceptions to this rule were garrison creeping foxtail, which failed to establish, and Italian annual ryegrass. Italian annual ryegrass should be planted each year in the Colorado High Plains climate. Both of these forage species may be useful under irrigated forage systems when managed appropriately.

All of the three warm season grasses (eastern gamagrass, big bluestem, and switchgrass) yielded less than three tons in 2003. Switchgrass was the only warm season grass that produced any harvestable yield in 2002 but it failed to recover adequately for the 2003 season under our management. Low cutting heights in 2002 may have hampered switchgrass vigor in 2003. Based upon the results of the three years of this trial, planting warm season perennial grasses under irrigation are not recommended due to the long establishment time.

Tall fescue produced the greatest forage yield in 2002 and 2003. However, it is less palatable to cattle than orchardgrass and bromegrasses in grazed pastures. It should be considered for irrigated pasture plantings especially where late fall and winter forage requirements are needed.

Orchardgrass was consistently the next highest forage producer compared to tall fescue in perennial grass production. It yielded between 75% and 80% percent of the total annual production of the tall fescue. Orchardgrass quality, as measured by CP and ADF, was generally among the top ranked forages. It also has a very good reputation for excellent palatability for all domestic livestock.

No yield advantages were noted to the inclusion of legumes (alfalfa, birdsfoot trefoil, and sainfoin) with the orchardgrass throughout the trial. Management practices in this trial favored the grass species. Legumes in grass mixes can improve forage production and quality with a more balanced management.

Meadow brome, perennial ryegrass, Newhy wheatgrass, pubescent wheatgrass, and the experimental prairie brome yielded statistically equal to orchardgrass in tonnage and also maintained respectable forage quality. Each of these grasses should be considered for irrigated forage situations based upon their other desired traits.

Tall wheatgrass and Matua prairie brome ranked at the bottom for yield in this trial in both years. Lincoln smooth brome may be useful under limited irrigation situations where its spreading growth habit, good palatability, and good persistence characteristics are desired. Tall wheat grass has good salt tolerance but is very poor in palatability and has limited utility for any irrigated situation. Matua prairie brome is not recommended for use as an irrigated forage in Colorado's high plains environment.

Species Seasonal Growth

The seasonality of growth for each of the different forage species can be useful in timing grazing resources for livestock. Optimum growth of cool season grasses is achieved at temperatures between 65 and 75 degrees Fahrenheit. These grasses grow rapidly early and reach maturity by late spring. Aggressive management during this time of the year can extend vegetative growth into the summer for some species. Growth rates generally slow during the summer months and some species may go dormant. Most species resume growth in the late summer and fall. Each grass species has its own specific growth characteristics throughout the season. The growth seasonality factors include earliness of breaking winter dormancy, fall dormancy, in the fall, heading characteristics, and rates of growth in the spring, summer, and fall.

The growth seasonality characteristics for forage species can also assist producers selecting forages or combinations of forages to fit limited irrigation system situations. Species which have a pattern of summer dormancy may be a good fit for cropping systems where limited irrigation water can be applied to the forage crop in early spring and fall. Water can then be diverted to use on other crops within the same field or other fields.

Three grass species have higher summer production than other cool season perennial species: experimental prairie brome, meadow brome, and orchardgrass (figure 4). These species fit when forage is needed throughout the summer. However, growth rate of these species also slows by late June and through July and much of August. Experimental prairie brome produces slowly in early spring but maintains productivity through the remainder of the season.

The wheatgrasses (Newhy, tall, and pubescent) produce heavily in the early to mid spring. Growth rate is low throughout the rest of the year. Perennial ryegrass also fits this pattern but with a slower early spring growth. These species then resume growth for late summer and fall cuttings. Tall fescue also exhibits this growth pattern and has excellent late-summer and fall production potential under proper management, (figure 5).

The seasonality of growth when using a continuous crop system varies by the type of summer annual grass used (figure6). Some annual summer forages have poor re-growth characteristics (foxtail millet), while others continue growth following cutting (sorghum x sudangrass).

Some older varieties of tall fescue are infected with a fungus that grows between the cells of the plant. This is called an endophyte fungus. This fungus increases drought tolerance and insect resistance in the plant. However, it produces toxins that are powerful vasoconstrictors in livestock, especially impacting peripheral blood vessels. This can have dramatic negative impacts on livestock that graze endophyte infected tall fescue or consume endophyte infected tall fescue hay. Symptoms and negative production impacts vary between animal species. Forage management techniques can help overcome, but not entirely eliminate, the impacts of these effects in some animal species.

There are varieties of tall fescue, such as Fuego that was used in this study, that do not contain the endophyte fungus. Since the fungus spreads via the seed, non-infected plants will never become infected with the endophyte fungus, nor will they produce infected seed. Additionally, there are new varieties of fescue being produced that contain a “novel” endophyte. This novel endophyte maintains the positive plant benefits of the endophyte but eliminates the negative animal impacts normally associated with endophyte infected tall fescue. Research trials in other locations throughout the U.S. have shown comparable animal performance when animals graze non-infected or novel infected tall fescue. Consequently, selections of tall fescue need to be made on their endophyte status for irrigated pastures plantings.

Conclusion:

The results of this trial demonstrated that there are several perennial and annual grass species which can be used to produce irrigated forages at relatively high production levels with good forage quality. In addition, a double cropping system using winter annual cereals as forage followed with a sorghum-sudan or forage millet is a practical production option. Adequate fertilizer, especially nitrogen, is necessary for irrigated forage production.

The double crop system of winter and summer annuals increases flexibility of land and water resource use. However, it will require higher annual planting and management inputs. This double crop system being the most flexible system allows for a return to field crops in a planned or unplanned rotation.

Secondly, it was not attempted to establish the proper fertilizer rates for nitrogen in these trials. Because forage growth is dependent upon the availability of both soil water and plant nutrients studies are needed to establish the nitrogen requirements under differing irrigation strategies. The timing of the split nitrogen applications also needs further work.

Finally, harvesting forages with a flail chopper does not directly compare with conventional haying practices. Similarly, forage harvest and utilization by grazing livestock is expected to show some differences in animal performance relative to different forage species. This study did not address the palatability of these forages under either grazing or haying management.

The selection of forage species must take into account persistence, yield distribution throughout the growing season, forage quality and palatability. We have attempted to identify some forage species that show potential for use in irrigated forage production systems in Northeast Colorado. Further study of the agronomic practices necessary for these species as well as animal performance date is needed.

There are several limitations to applying this trial information directly to farming and grazing managed fields. Further research is needed to establish how these different forage species perform under limited irrigation systems, both in the amount of water used through the season and the seasonal timing of the irrigations. Each perennial forage species used under limited irrigation should be tested for the effect that an imposed period of drought has upon both the time and water required to break dormancy once irrigation has resumed and the survivability of the forage stand.

Table 1

Forage Species in Irrigated Trial

Treat-ment Number	Description	Recommended seeding rate lbs/a, (PLS)	Treat-ment Number	Description	Recommended Seeding rate lbs/a, (PLS)
1	Winter Triticale	90	11	Big Bluestem	11
1a	Sorghum x Sudangrass	20	12	Switchgrass	5
2	Winter Wheat	90	13	Orchardgrass/Alfalfa	5/6
2a	Foxtail Millet	20	14	Orchardgrass/Birdsfoot Trefoil	5/6
3	Experimental Prairie Brome	20	15	Orchardgrass/Sainfoin	5/20
4	Eastern Gamagrass	10	16	Wheatgrass - Newhy	14
5	Meadow Brome	17	17	Tall Wheatgrass	20
6	Orchardgrass	6	18	Pubescent Wheatgrass	15
7	Smooth Brome	10	19	Prairie Bromegrass (Matua)	20
8	Perennial Ryegrass	8	20	Creeping Foxtail	3
9	Tall Fescue	8	21	Annual Ryegrass (2002)	8
			21	Oats Ogle (2003)	120

Figure 1

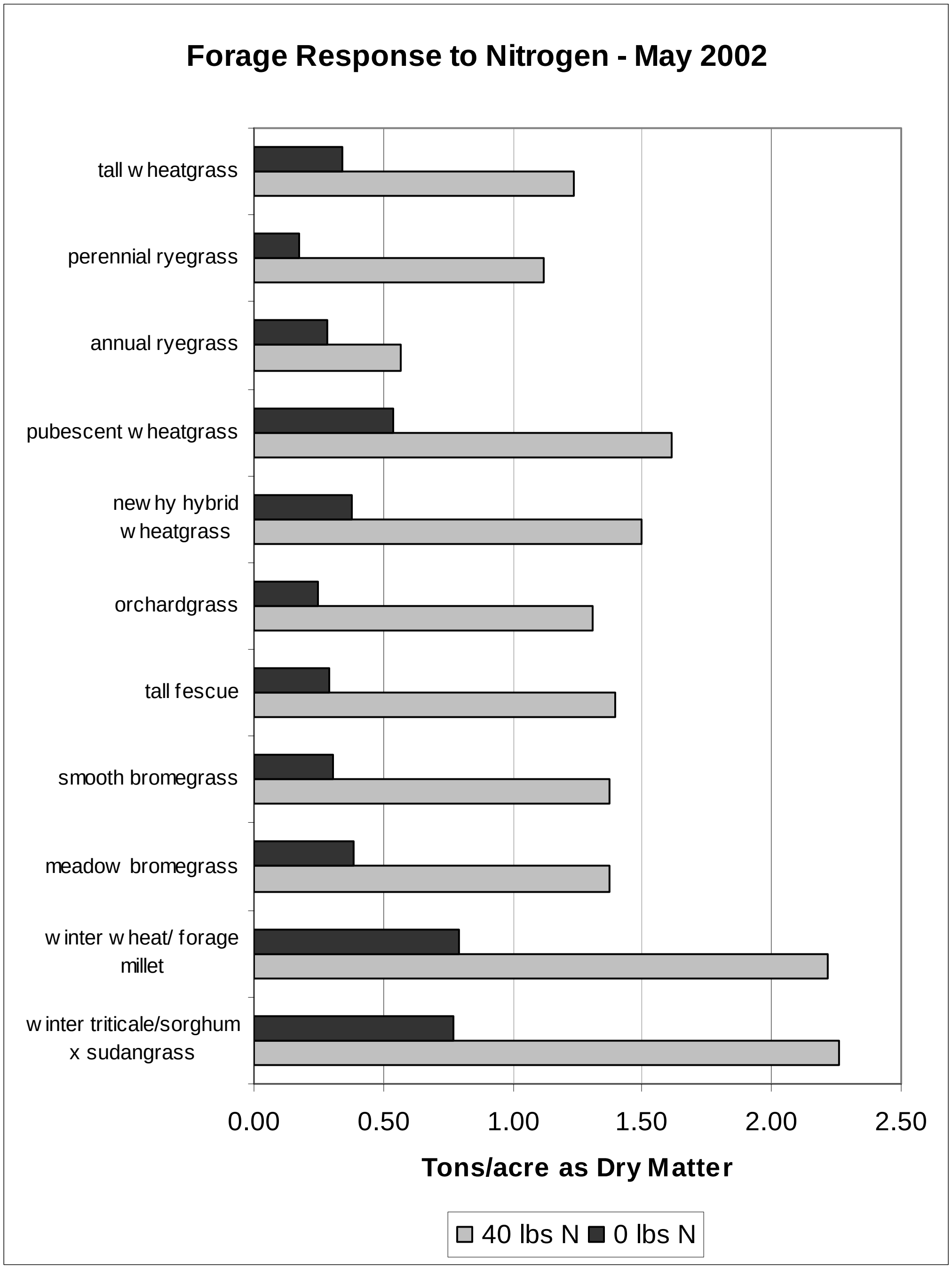
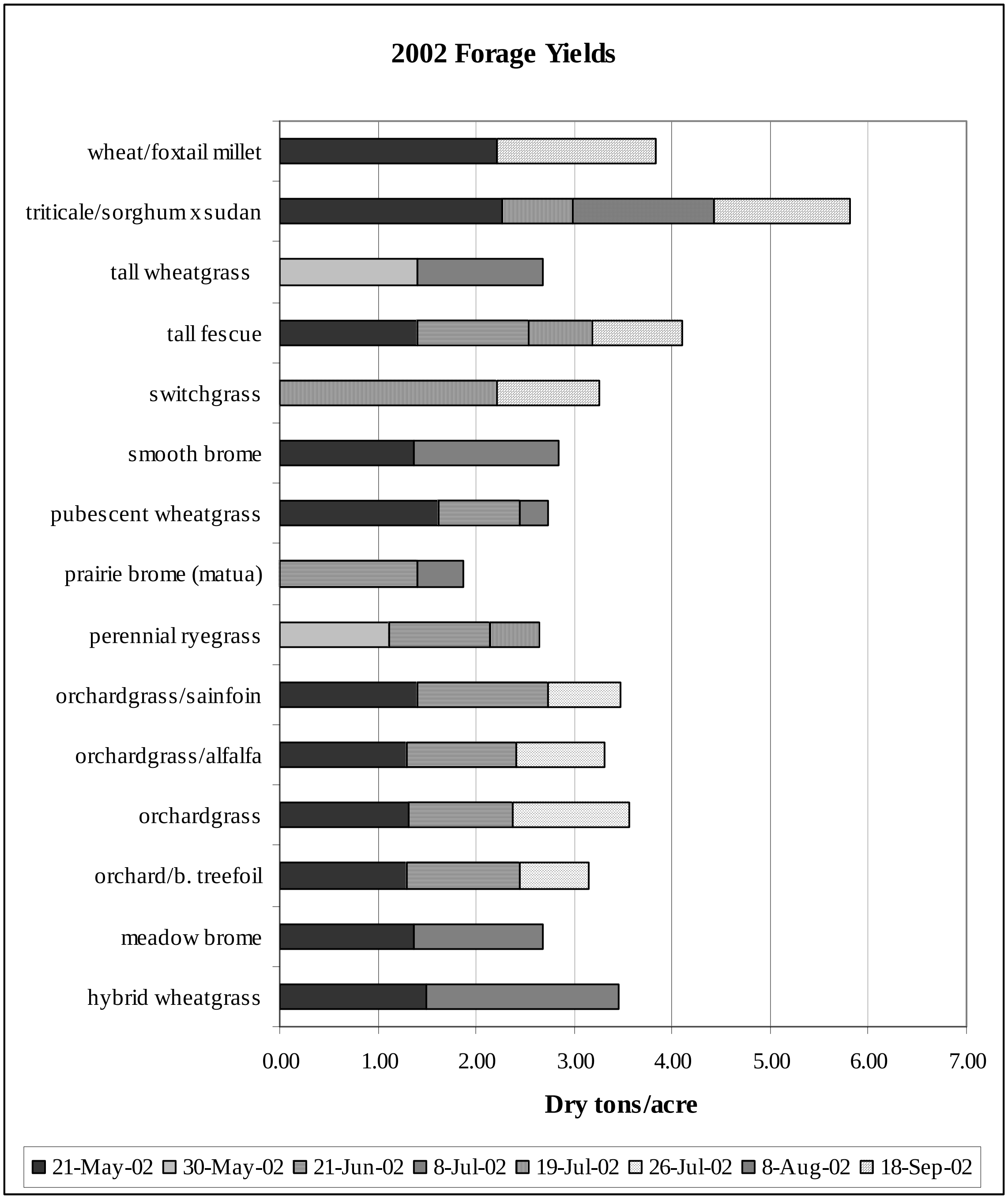
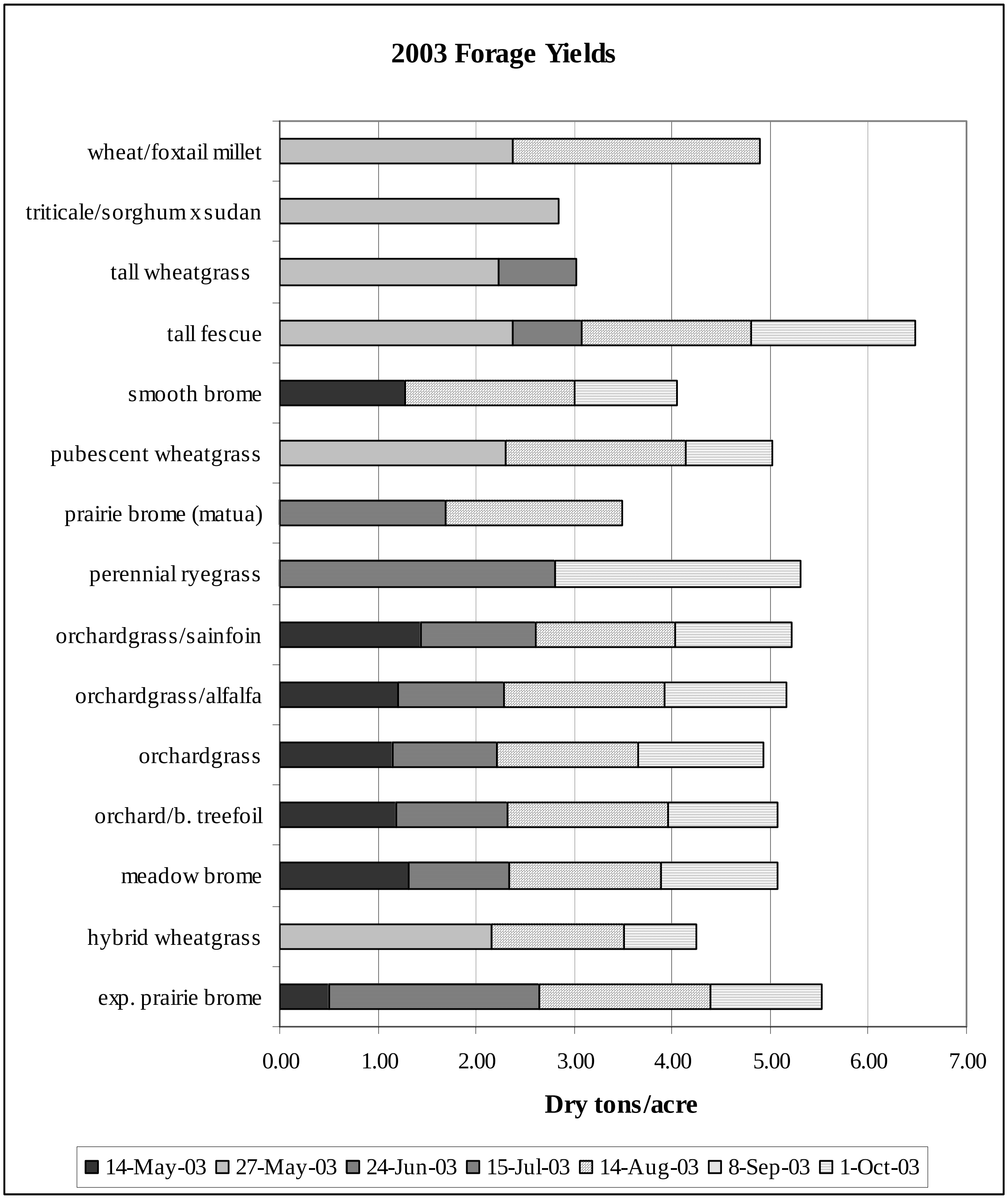

Forage Response to Nitrogen - May 2002
tall w heatgrass
perennial ryegrass
annual ryegrass
pubescent w heatgrass
new hy hybrid w heatgrass
orchardgrass
tall fescue
smooth bromegrass
meadow bromegrass
w inter w heat/ forage millet
w inter triticale/sorghum x sudangrass
0.00
0.50
1.00
1.50
2.00
2.50
Tons/acre as Dry Matter
40 lbs N
0 lbs N

Figure 2



2002 Forage Yields
wheat/foxtail millet
triticale/sorghum x sudan
tall wheatgrass
tall fescue
switchgrass
smooth brome
pubescent wheatgrass
prairie brome (matua)
perennial ryegrass
orchardgrass/sainfoin
orchardgrass/alfalfa
orchardgrass
orchard/b. treefoil
meadow brome
hybrid wheatgrass
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Dry tons/acre
21-May-02
30-May-02
21-Jun-02
8-Jul-02
19-Jul-02
26-Jul-02
8-Aug-02
18-Sep-02

Figure 3



2003 Forage Yields
wheat/foxtail millet
triticale/sorghum x sudan
tall wheatgrass
tall fescue
smooth brome
pubescent wheatgrass
prairie brome (matua)
perennial ryegrass
orchardgrass/sainfoin
orchardgrass/alfalfa
orchardgrass
orchard/b. treefoil
meadow brome
hybrid wheatgrass
exp. prairie brome
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
Dry tons/acre
14-May-03
27-May-03
24-Jun-03
15-Jul-03
14-Aug-03
8-Sep-03
1-Oct-03

Figure 4

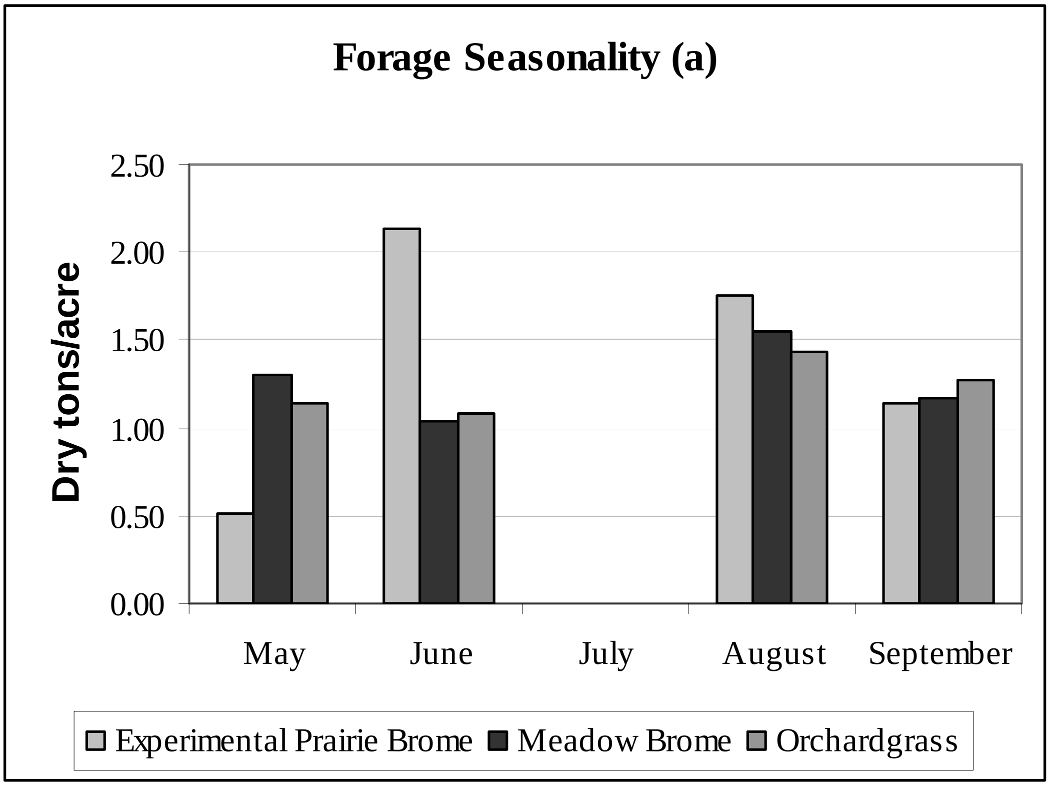


Figure 5

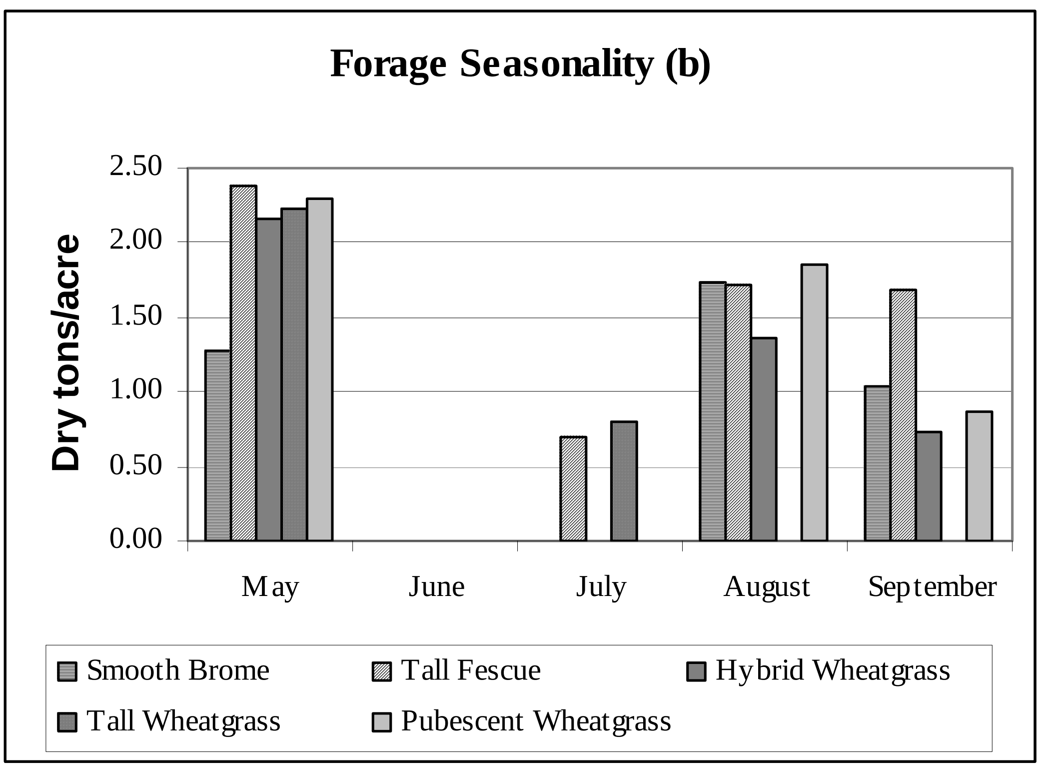


Figure 6

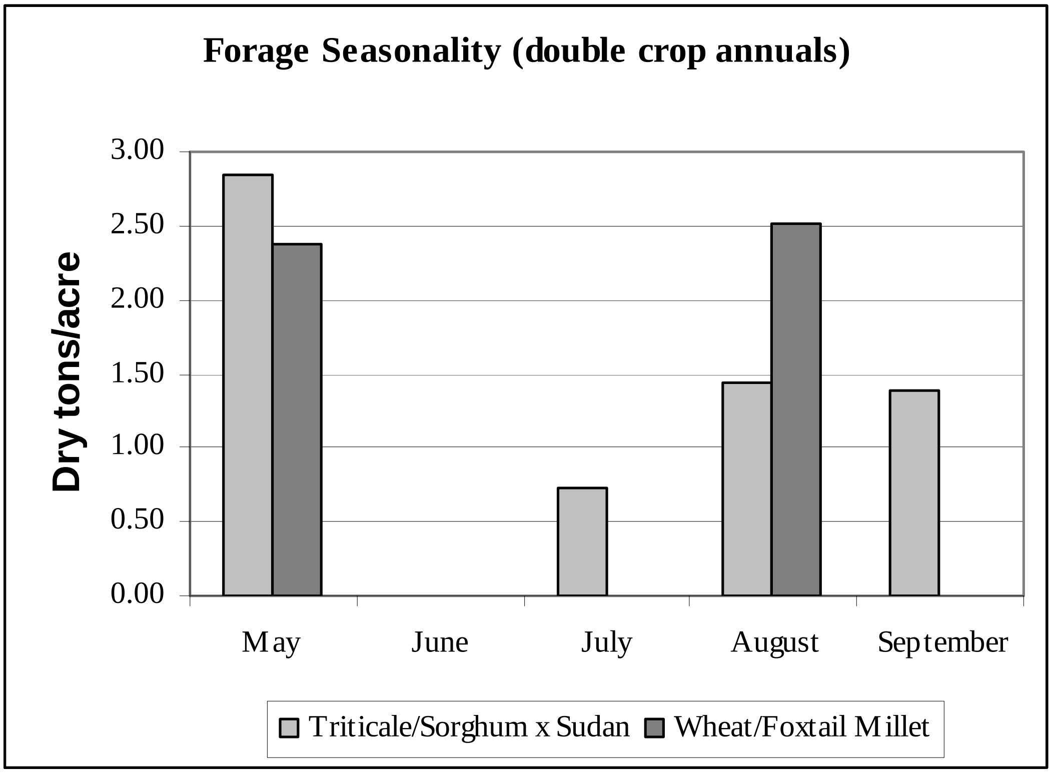

Forage Seasonality (double crop annuals)
Dry tons/acre
3.00
2.50
2.00
1.50
1.00
0.50
0.00
May
June
July
August
September
Triticale/Sorghum x Sudan
Wheat/Foxtail Millet

Table 2

Plot Num	**2002 and 2003 Summary Yield Chart** Forage Species (CV)	02 Yield Tons/A		03 Yield Tons/A		02 & '03 Combined Tons/A	
1	Triticale	2.26	fgh	2.84	fg	2.55	efgh
1a	Sorghum x Sudan	3.55	b				
2	Wheat (Longhorn)	2.22	gh	2.37	gh	2.29	gh
2a	Forage Millet (White Wonder)	1.62	i	2.52	gh	2.07	gh
21	Oats (Ogle) 2003 only			2.66	gh		
3	Experimental Prairie Brome			5.53	b		
4	Eastern Gama grass			2.40	gh		
5	Meadow Brome (Regar)	2.68	defg	5.07	b	3.87	bc
6	Orchardgrass (Latar)	3.24	bcde	4.94	bc	4.09	bc
7	Smooth Brome (Lincoln)	2.85	cdefg	4.04	de	3.45	bcde
8	Perennial Ryegrass (Herbie)	2.64	efg	5.30	b	3.97	bc
9	Tall Fescue (Fuego)	4.11	a	6.48	a	5.30	a
11	Big Bluestem (Kaw)			1.87	h		
12	Switchgrass (Neb 28)	3.26	bcde				
13	Alfalfa/Orchardgrass	3.31	bcd	5.17	b	4.24	b
14	Birdsfoot Trefoil/Orchardgrass	3.15	bcde	5.07	b	4.11	bc
15	Sainfoin/Orchardgrass	3.47	bc	5.22	b	4.34	b
16	Wheatgrass (Newhy)	3.46	bc	4.25	cd	3.86	bc
17	Tall Wheatgrass (Jose')	2.68	defg	3.02	fg	2.85	defg
18	Pubescent Wheatgrass (Luna)	2.73	defg	5.02	b	3.87	bc
19	Prairie Bromegrass (Matua or Atom)	1.87	hi	3.48	ef	2.68	defgh
	Average	2.87		4.07		3.54	
	LSD (10%)	0.55		0.72		0.81	

* Yields in the same column followed by the same letter(s) are not significantly different

Table 3

2002 and 2003 Summary Crude Protein Chart

Plot Num	Forage Species (CV)	02 Crude Protein %		03 Crude Protein %		Average CP %	
1	Triticale	12.28	h	12.88	fg	12.58	de
1a	Sorghum x Sudan	15.76	bcde				
2	Wheat (Longhorn)	10.50	i	15.10	bcde	12.80	de
2a	Forage Millet (White Wonder)	6.60	j	12.45	fg	9.53	f
21	Oats (Ogle) 2003 only			12.00	g		
3	Experimental Prairie Brome			13.25	fg		
4	Eastern Gama grass			13.93	def		
5	Meadow Brome (Regar)	14.26	efg	15.61	bc	14.94	abc
6	Orchardgrass (Latar)	16.56	ab	15.85	bc	16.21	a
7	Smooth Brome (Lincoln)	14.42	defg	17.51	a	15.97	a
8	Perennial Ryegrass (Herbie)	14.89	cdef	11.83	g	13.36	cde
9	Tall Fescue (Fuego)	13.92	fg	12.40	fg	13.16	de
11	Big Bluestem (Kaw)			16.43	abc		
12	Switchgrass (Neb 28)	9.77	i				
13	Alfalfa/Orchardgrass	16.89	ab	16.71	abc	16.80	a
14	Birdsfoot Trefoil/Orchardgrass	16.39	b	15.39	bcd	15.89	a
15	Sainfoin/Orchardgrass	15.47	bcde	14.96	cde	15.22	ab
16	Wheatgrass (Newhy)	14.75	def	15.58	bc	15.17	ab
17	Tall Wheatgrass (Jose')	13.06	gh	12.95	fg	13.01	de
18	Pubescent Wheatgrass (Luna)	16.21	bc	15.52	bc	15.87	a
19	Prairie Bromegrass (Matua or Atom)	16.60	ab	13.75	ef	15.18	ab
	Average	14.02		14.43		14.38	
	LSD (10%)	1.29		1.42		1.59	

* Crude Protein levels are averaged over all cuttings for each treatment. Means within the same column followed by the same letters(s) are not significantly different

Table 4

2002 and 2003 Summary Acid Detergent Fiber (ADF) Chart

Plot Num	Forage Species (CV)	02 ADF %		03 ADF %		Average ADF %	
1	Triticale	29.20	a	32.83	bc	31.01	ab
1a	Sorghum x Sudan	31.04	bc				
2	Wheat (Longhorn)	29.98	ab	30.10	a	30.04	a
2a	Forage Millet (White Wonder)	36.27	f	40.13	f	38.20	g
21	Oats (Ogle) 2003 only			32.65	b		
3	Experimental Prairie Brome			36.83	e		
4	Eastern Gama grass			39.65	f		
5	Meadow Brome (Regar)	35.40	f	35.71	a	35.56	ef
6	Orchardgrass (Latar)	30.95	bc	34.18	bcd	32.57	c
7	Smooth Brome (Lincoln)	36.46	f	34.10	bcd	35.28	de
8	Perennial Ryegrass (Herbie)	31.50	bcd	34.76	cd	33.13	c
9	Tall Fescue (Fuego)	32.93	de	34.63	bcd	33.78	cd
11	Big Bluestem (Kaw)			36.78	e		
12	Switchgrass (Neb 28)	35.16	f				
13	Alfalfa/Orchardgrass	31.19	bc	34.56	bcd	32.88	c
14	Birdsfoot Trefoil/Orchardgrass	31.17	bc	34.67	bcd	32.92	c
15	Sainfoin/Orchardgrass	31.76	cde	33.20	bc	32.48	bcde
16	Wheatgrass (Newhy)	33.25	e	33.77	bcd	33.51	c
17	Tall Wheatgrass (Jose')	35.50	f	36.88	e	36.19	ef
18	Pubescent Wheatgrass (Luna)	30.72	abc	33.70	bcd	32.21	bc
19	Prairie Bromegrass (Matua or Atom)	35.28	f	34.80	cd	35.04	de
	Average	32.81		34.94		33.88	
	LSD (10%)	1.68		1.76		1.34	

* Acid Detergent Fiber levels are averaged over all cuttings for each treatment. Means within the same column followed by the same letters(s) are not significantly different.

Table 5

2002 and 2003 Summary Total Digestible Nutrients (TDN) Chart

Plot Num	Forage Species (CV)	02 TDN %		03 TDN %		Average TDN %	
1	Triticale	69.18	a	65.78	b	67.48	abc
1a	Sorghum x Sudan	67.76	ab				
2	Wheat (Longhorn)	68.93	ab	68.80	a	68.87	a
2a	Forage Millet (White Wonder)	61.97	e	57.68	e	59.82	h
21	Oats (Ogle) 2003 only			66.00	b		
3	Experimental Prairie Brome			61.31	d		
4	Eastern Gama grass			57.45	e		
5	Meadow Brome (Regar)	62.98	e	62.57	cd	62.78	fg
6	Orchardgrass (Latar)	67.85	ab	64.26	bc	66.06	cd
7	Smooth Brome (Lincoln)	61.76	e	64.31	bc	63.04	ef
8	Perennial Ryegrass (Herbie)	67.27	abc	63.66	bc	65.47	d
9	Tall Fescue (Fuego)	65.66	cd	63.77	bc	64.72	de
11	Big Bluestem (Kaw)			61.38	d		
12	Switchgrass (Neb 28)	63.18	e				
13	Alfalfa/Orchardgrass	67.59	ab	63.83	bc	65.71	d
14	Birdsfoot Trefoil/Orchardgrass	67.21	abc	63.74	bc	65.48	d
15	Sainfoin/Orchardgrass	66.98	bcd	65.36	b	65.02	bcd
16	Wheatgrass (Newhy)	65.30	d	64.74	bc	62.05	d
17	Tall Wheatgrass (Jose')	62.81	e	61.28	d	66.47	fg
18	Pubescent Wheatgrass (Luna)	68.12	ab	64.81	bc	66.47	bcd
19	Prairie Bromegrass (Matua or Atom)	63.07	e	63.58	bcd	63.33	ef
	Average	65.74		63.83		64.83	
	LSD (10%)	1.71		2.07		1.51	

* Total Digestible Nutrient (TDN) levels are averaged over all cuttings for each treatment. Means within the same column followed by the same letters(s) are not significantly different.

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FORAGE PEA STUDY

Ron F. Meyer

Introduction

Irrigated forage production in the Colorado High Plains has been increasing. Producers are looking for flexible forage production options that fit into High Plains cropping systems. In addition, irrigation wells within the High Plains region have been losing capacity. Many of these wells are strained to pump enough water just to meet the evapotranspiration demands of some summer crops. The purpose of this study was to investigate early season forage crops that have satisfactory yield and quality potential but reduced irrigation demand.

Materials and Methods

During the 2003 growing season, forage peas were planted in combination with triticale and oats (Table 1). Three pea varieties (Arvika, Forager, and Salute) were investigated along with two oat varieties (114 and 126) and one triticale variety (Lazer). Data were obtained for yield, crude protein, acid detergent fiber (ADF), total digestible nutrients (TDN), Ca, P, and nitrate-nitrogen. All data are reported on a dry matter basis. Plots were 5 ft. wide by 33 ft. long. The experiment was a randomized complete block design with three replications. Plots were planted on 25 March 2003 and harvested on 16 June 2003. Harvested area was 3 ft. wide by 30 ft. long. No herbicides or fertilizers were applied. The study was sprinkler-irrigated with a center pivot system and 4 in. of irrigation water were applied during the growing season. The study was located at the Glenn Adolf farm near Burlington, Colorado (elevation 4,220 ft. above sea level). Harvest was performed when the triticale was in the boot stage, however, the oats tested were late varieties and were still pre-boot. Plot Harvest was accomplished in tandem with the cooperator's field harvest schedule.

Results and Discussion

Yield and forage quality of the triticale, oat, and pea varieties are presented in Table 2. Lazer triticale, planted as a sole crop, was one of the highest yielding entries while Arvika and Salute peas as a sole crop yielded the lowest. Planting Lazer triticale with Arvika and Forager peas increased yields over planting the peas alone, but Lazer did not increase yield when planted with Salute peas. Oats (126) planted with Forager peas did not yield as well as the Forager pea/Lazer triticale mix. Oats (114) planted alone was the fourth highest yielding entry.

Crude protein was highest in the Arvika pea, Salute pea, Forager pea/oat, and oat (114) entries. The addition of Lazer triticale to forage peas decreased protein levels, but yields were increased. Further, the oat entries studied appeared to have the potential to increase protein levels similar to levels expressed by peas alone.

The addition of forage peas to Lazer triticale did not affect levels of ADF, TDN, Ca, P, or nitrate-nitrogen. Oats, when compared to triticale, had higher protein and TDN levels, with correspondingly lower levels of ADF. Taken together these are forage indicators that oats had higher forage digestibility and lower total fiber content than triticale. Calcium levels between oats and triticale were similar. TDN levels were highest in oats (114) and the Arvika and Salute peas and lowest in entries that contained Lazer triticale.

Legumes tend to have higher levels of Ca compared to grasses. The highest levels of Ca in this study were found in the Arvika and Salute peas planted as a sole crop.

Nitrate-nitrogen levels were highest in the Forager pea/oat and oat (114) entries, but were below toxic levels.

Summary

Producers concerned with only yield should consider planting triticale alone. Planting oats alone will provide a balance between yield and forage quality. The yield for oats was acceptable at 3.2 tons/acre, but the oats had significantly higher crude protein and TDN levels compared to the triticale. Planting forage peas with triticale has the potential to improve forage quality, but only marginally. In order to make a difference in forage quality, peas should contribute a larger percentage to total yield. Keep in mind these data are for one year only. Often data obtained in field studies must be collected over 2 or more years in order to draw meaningful conclusions.

Table 1. Seeding rates of various triticale, oat, and pea varieties grown under irrigation on the Glenn Adolf farm near Burlington, Colorado in 2003.

Forage Species/Variety	Seeding Rate lbs/acre
Arvika Pea/Lazer Triticale	70/70
Lazer Triticale	140
Forager Pea/Lazer Triticale	70/70
Oats (114)	100
Forager Pea/Oats (126)	70/140
Salute Pea/Lazer Triticale	100/30
Salute Pea	110
Arvika Pea	110

Table 2. Yield and forage quality of various triticale, oat, and pea varieties grown under irrigation on the Glenn Adolf farm near Burlington, Colorado in 2003.

Forage Species/Variety	Yield tons/acre	Protein %	ADF %	TDN %	Ca %	P %	NO_3-N ppm
Arvika Pea/Lazer Triticale	4.00a	13.5b	43.7cde	53.6cde	0.41b	0.35bc	1147d
Lazer Triticale	3.97a	12.6b	45.4e	51.7e	0.39b	0.33c	1488cd
Forager Pea/Lazer Triticale	3.67abc	14.4b	42.0bcd	55.5bcd	0.42b	0.33c	1315cd
Oats (114)	3.20abcd	19.5a	36.0a	62.2a	0.59b	0.39abc	2400b
Forager Pea/Oats (126)	3.00bcd	18.1a	40.9bc	56.8bc	0.63b	0.45ab	4087a
Salute Pea/Lazer Triticale	2.70cd	16.0ab	44.8de	52.4de	0.52b	0.37abc	1698c
Salute Pea	2.30de	18.1a	39.7b	58.2b	1.03a	0.38abc	421e
Arvika Pea	1.56e	19.3a	39.9b	57.9b	0.99a	0.48a	387e

Means within a column followed by the same letter are not different from one another. Data are reported on a dry matter basis.

DRYLAND ANNUAL FORAGES

Ron F. Meyer, D. Bruce Bosley, Joel P. Schneekloth
Merle Vigil, and Gene Schmitz

Introduction

Dryland forage production within Colorado's High Plains has become increasingly important. As a result of recent dry growing season conditions, cattlemen are searching for dryland forage options. Even when normal growing conditions resume, cattlemen oftentimes are in need of supplemental forages. The objective of this study was to evaluate various annual forages for yield and forage quality under dryland conditions in northeastern Colorado.

Materials and Methods

Dryland annual forages were planted during the 2001, 2002, and 2003 growing seasons at the USDA-ARS Central Great Plains Research Station near Akron, Colorado. Each year's study was situated in a different field location from the previous year in order to minimize year to year field variability. Each year's trial was planted in the stubble of a uniformly managed dryland corn crop from the previous season. Ten forages were investigated in 2001 and 2002, with three more added in 2003 (Table 1). During the 2001 and 2002 seasons, the following forages were planted: oats, barley, triticale, soybean, forage sorghum, proso millet, foxtail millet, pearl millet, sorghum sudan, and forage kochia. Oats, barley, triticale, and forage kochia were planted in late March or early April with the other entries planted in late May or early June, depending on the year. During the 2003 growing season, three additional sorghum sudan varieties were added: a photo period sensitive brown mid-rib, a photo period insensitive brown mid-rib, and a variety called Atta Graze. Forage kochia did not establish in any year and those plots were allowed to go to weeds. A "weed" plot was subsequently harvested for yield and forage quality as a potential indicator of emergency feed. The experimental design was a randomized complete block with 4 replications.

The plots were no-till planted into corn stubble all three seasons. No fertilizer was applied. The only herbicide application was 1 quart per acre of Roundup pre-plant in 2001 and 2002. There was no herbicide application to plots in 2003. The oat, barley, and triticale plots were harvested on 26 July 2001, 24 June 2002, and 18 June 2003. All other plots were harvested on August 1 and September 23 in 2001 and 2002, respectively. In 2003, the proso millet and weed plots were harvested on August 13 with all remaining plots harvested on August 29. Harvest timing was based on plant growth, with boot stage the target.

Results

Sorghum sudan entries consistently yielded the highest over all 3 years of this study, regardless of precipitation received. However, yields from 2003 were not significantly different due to excess weed infestations. Triticale and oats also yielded well. It does appear, however, that when spring conditions are favorable, triticale yields better than oats, but when dryer conditions exist, oats may be a better choice, as was observed in 2002. This condition appears to hold for protein produced per acre as well.

Other quality parameters were measured in an effort to gain an insight into which cultivar would produce the highest forage quality in conjunction with yield. Not all quality parameters were measured from each entry every year. However, when protein produced per acre was measured, sorghum sudan produced well most years, as did triticale. Both triticale and oats appeared to be a satisfactory protein source most years. Soybean was found to produce above average protein percentages, but could not compete from a yield standpoint and as a result, per acre protein production was reduced accordingly. Proso millet produced the highest TDN levels in 2001 and 2003, but was not harvested in 2002 due to drought conditions and weed infestations. Dry weather in 2002 prevented harvest of the weed, foxtail millet, proso millet, and soybean plots.

Acid detergent fiber (ADF) test values serve as a useful index of forage digestibility. Based on ADF test levels, soybeans ranked statistically highest and proso millet ranked second with all other treatments in 2001. Similarly, sorghum sudan and pearl millet ranked equal and at the top in 2002 with forage sorghum and barley ranking third and fourth respectively that year. These differences in ADF, and parenthetically digestible forage quality, are most likely due to differences in harvest timing relative to each forage treatments stage of development. Neutral Detergent Fiber (NDF) test values were conducted for the 2001 trials and obtained similar but not identical treatment separations to ADF.

Nitrates were measured from some entries in 2001 and 2003. All nitrate levels were below toxic levels.

In summary, it appears that sorghum sudan is a good dryland forage choice from both a yield and forage quality standpoint. Triticale and oats can also perform well when early season moisture exists.

Table 1. Various species, varieties, and seeding rates of annual forages planted under dryland conditions at the USDA-ARS Central Great Plains Research Station near Akron, Colorado.

Crop	Planting Rate (lbs/acre)	Variety
Oats	100	Ogle
Barley	100	Otis
Triticale	100	Presto
Soybean	60	Agripro 2802rr
Forage Sorghum	25	Kaystar Millenium
Proso Millet	18	Huntsman
Foxtail Millet	15	White Wonder
Pearl Millet	20	Pawnee
Sorghum Sudan	25	Triumph Sooner Sweet
Added in 2003		
Sorghum Sudan	25	311 Brown Mid-rib (Photo period sensitive)
Sorghum Sudan	25	211 Brown Mid-rib (Photo period insensitive)
Sorghum Sudan	25	Atta Graze

Table 2. Yield and quality of various annual forages grown under dryland conditions at the USDA-ARS Central Great Plains Research Station near Akron, Colorado in 2001.

Cultivar	Yield (tons/acre)	Protein (lbs/acre)	TDN (%)	ADF (%)	NDF (%)	Nitrate-N (ppm)
Sorghum/Sudan	2.54a	346bc	62cd	36c	62cd	63a
Triticale	2.40ab	609a	63cd	37c	--	--
Barley	2.30ab	600a	65bc	33c	--	--
Proso Millet	2.10abc	329bc	70a	29b	57bc	21a
Oats	1.90abcd	415b	61d	37c	--	--
Forage Sorghum	1.70bcd	291bc	64cd	35c	61cd	114a
Foxtail Millet	1.50cd	218c	64cd	34c	62cd	44a
Soybean	1.50cd	346bc	68ab	25a	36a	41a
Pearl Millet	1.30d	210c	63cd	35c	63d	63a
Weeds	1.20d	216c	63cd	35c	54b	199a

Numbers within a column followed by the same letters are not different.

Table 3. Yield and quality of various annual forages grown under dryland conditions at the USDA-ARS Central Great Plains Research Station near Akron, Colorado in 2002. Dry weather in 2002 prevented harvest of the weed, foxtail millet, proso millet, and soybean plots.

Cultivar	Yield (tons/acre)	Protein (lbs/acre)	TDN (%)	ADF (%)	NDF (%)	Nitrate-N (ppm)
Forage Sorghum	1.98a	527a	66b	32b	--	--
Sorghum Sudan	1.86a	552a	70a	29a	--	--
Oats	1.7a	222bc	51d	--	--	--
Pearl Millet	1.2ab	429ab	68ab	29a	--	--
Triticale	0.7b	97cd	49d	--	--	--
Barley	0.6b	49d	54c	37c	--	--

Numbers within a column followed by the same letters are not different.

Table 4. Yield and quality of various annual forages grown under dryland conditions at the USDA-ARS Central Great Plains Research Station near Akron, Colorado in 2003.

Cultivar	Yield (tons/acre)	Protein (lbs/acre)	TDN (%)	ADF (%)	NDF (%)	Nitrate-N (ppm)
Atta Graze Sorghum Sudan	2.1a	--	--	32ab	--	394bc
Forage Sorghum	2.0a	718a	54d	34bc	--	--
Triticale	1.9a	519ab	60bc	36cde	--	393bc
Weeds	1.9a	322bc	64ab	35cd	--	--
Pearl Millet	1.8a	--	--	38e	--	578ab
Photo Period Insensitive S/S	1.6a	--	--	31a	--	378bc
Soybean	1.6a	551a	59bcd	35cd	--	--
Sorghum Sudan	1.6a	--	--	34bc	--	880a
Photo Period Sensitive S/S	1.5a	--	--	34bc	--	298bcd
Proso Millet	1.5a	300c	68a	34bc	--	--
Oats	1.3a	327bc	57cd	37de	--	575ab
Barley	0.9a	279c	65ab	34bc	--	192cd
Foxtail Millet	--	--	--	--	--	--

Numbers within a column followed by the same letters are not different.