FORAGE YIELD AND QUALITY OF WARM SEASON ANNUAL CEREAL CROPS IN THE NORTHERN ALBERTA OF CANADA

AKIM TUNDE OMOKANYE

Peace Country Beef & Forage Association (Agricultural Research and Extension Council of Alberta), Animal Science Building, GPRC, 11235-98 Avenue, Fairview, Alberta, T0H 1L0 Canada

ABSTRACT

In Alberta Canada, many livestock producers look at alternative ways to reduce their winter feed costs through a series of options to extend the summer grazing season into the fall and winter months. Cool season cereals, such as oat and barley play significant role in providing winter feed in the form of greenfeed hay, silage and swath grazing. The objective of the present study was to evaluate warm season cereals (9 corn hybrids, 2 millet varieties and a forage sorghum hybrid, CFSH 30) in a temperate environment compared to temperate cool season cereals (2 oat varieties - controls) for forage dry matter (DM) yield and nutritive value. The corn hybrids mostly had higher forage DM yield than other crop types (millets, sorghum and oat).The forage DM yield significantly ($P<0.05$) varied from 3878 kg ha^{-1} for German millet to 11529 kg ha^{-1} for 39M26 corn hybrid.Both millets and CFSH 30 had significantly higher crude protein (CP) than corn hybrids as well as the two cool season crop controls (oat). The forage CP was lowest (8.15%) for 39F44 corn hybrid and highest (14.8%) for German millet. The forage Ca, P, K and Mg respectively varied from 0.21-0.40%, 0.11-0.29%, 0.96-2.82% and 0.09-0.47%. The forage energy (total digestible nutrients, TDN) was mostly >60.0% for all crops tested.The findings from the present study are discussed as relating to selecting warm season crops for use in the beef cattle production systems in parts of the Peace Country region of Alberta, Canada, with focus on nutritive value in relation to the nutrient requirements of a mature beef cattle.

INTRODUCTION

The Peace country region of Alberta with an estimated 233,000 cattle and calves, represents 4.6% of Alberta's cattle and calves population. Winter feed is very costly for cow-calf operations in the region. To reduce feed costs and the overall yearly cost of production, beef cattle producers are exploring various options in lengthening the grazing season beyond the late summer months into the fall and winter seasons. In recent years in parts of the region, there is a gradual increase in the number of beef cattle producers looking forward to explore the potential and suitability of warm season cereals particularly, corn (*Zea mays*) in extending the grazing season. This is because of the reports emanating from the PC region (Omokanye, 2011) and elsewhere in Alberta (Baron *et al.*2012; McCartney *et al.* 2004) have indicated that grazing cattle on corn can lower winter feed costs, reduce operating expenses and save time. This operation does not require harvest and makes winter supplemental feeding so limited. Research to identify promising warm season cereal crops for livestock production systems is scanty in the PC region of Alberta; which occupies 11.1% of Alberta's total farmland (Government of Alberta, 2012). There is therefore a need for continued effort for recent data (on agronomic adaptation, forage yield and quality, and animal performance) as new warm season crop varieties/hybrids become available. The objective of this study was to identify warm season cereal crops (corn, millet (*Panicum miliaceum* L.) and sorghum (*Sorghum vulgare* Pers.) with higher forage yield and feed nutritive for beef cattle production, when grown in the Peace Region of Alberta, Canada.

MATERIALS AND METHODS

Experimental site- The trial was conducted in 2012on a dark gray chemozemics soil at Fairview Research Farm (56° 04' 53" N, 118° 26' 05" W; 661.4 m above sea level), in the PC region of Alberta, Canada. The site has a subarctic climate (also called boreal climate), which is characterized by long, usually very cold winters, and short, cool to mild summers. Monthly data for the 2012 and the long term (30 years) averages of the corn heat units (CHUs), rainfall, maximum and minimum temperatures are given in Table 1. Spring soil moisture at site was 39 mm. Soil temperature at seeding was 9.5°C.Soil test for the site at 0-15 cmsoil depth prior to seeding indicated a pH of 5.8 and 7.1% organic matter.

Treatments design and seeding procedure

The experimental design was a randomized complete block design with four replications. Prior to seeding, the site was harrowed and then sprayed with Credit® for a pre-seed weed control.Twelve warm season crops consisting of 9DuPont Pioneer®corn hybrids, 2 millet varieties (Red proso and German), a forage sorghum (Canadian forage sorghum hybrid, CFSH 30) and 2 cool season oat (*Avena sativa* L.) varieties(CDC Baler and CDC SO-I) formed the treatments. The 2 cool season oat crops were used as controls (C).The CHUs for corn hybrids varied from 2000 to 2350 (see Table 2). The crops were seeded into small plots measuring 2.5 m x 10 m. Seeding was done on May 18, 2012 at the rate of 80,000 kernels $ha^{-1}$for each corn hybrid and 22.5 kg ha^{-1} for Red proso& German millet and CFSH 30. The oat varieties were seeded at the rateof 112 kg $ha-^{1}$. A 6-row corn planter was used to seed corn, while millets, sorghum and oat were seeded with a 6-row no-till plot drill. Following soil test recommendations, fertilizer was broadcast at 56 kg N ha^{-1} + 22.4 kg P ha^{-1} prior to seeding. In crop spraying with RoundUp®at 0.67 L ha^{-1} was carried out to control weeds in the corn plots one month after seeding. For millets, CHFS 30 and oats, Basagran Forte® was used to control weeds at the recommended rate for each crop type.

Forage sampling and determination of forage nutritive value-

For forage DM yield determination, oat, millets and CFSH 30were harvested at the late milk stage(August-September, 2012), while the corn hybrids were harvested at the half milk line stage in early October, 2012. Each crop type was harvested at about 10 cm above ground from random 4 m lengths of 2 rows ($6.15m^2$)/plot. The freshly harvested forage materials were weighed, sub-sampled (about 0.5 kg), dried and reweighed for DM content and yield estimation. Dried forage samples of oat, millets and CFSH 30, and wet forage samples of corn hybrids were shipped out to a commercial laboratory (Central Testing Laboratory Limited, Winnipeg, Manitoba, Canada), for nutritive analysis using standard laboratory wet chemistry procedures. The forage nutritive values (reported on dry matter basis) were determined using two dry samples per treatment,composites from replications 1 & 2, and replications 3 & 4.

Data Analysis

The data were subjected to analysis of variance (ANOVA) using a pre-defined model inCostat procedure (CoStat Version 6.4, 2005). Where ANOVA indicated significant treatment effects, the means were separated by the leastsignificant difference (LSD) at the 0.05 probability level. Significant differences in the text refer to $P<0.05$.

RESULTS AND DISCUSSION

Forage DM yield- The DM yield varied from 3.88 kg ha^{-1} for German millet to 11529 kg ha^{-1} for 39M26 corn hybrid (Table 2). Generally, all corn hybrids (except for X70B144R1) had higher DM yields than other crop types. The forage DM yield obtained here was far higher than those earlier reported by Omokanye (2011) in the same environment. Higher rainfall was recorded in the present study than that recorded for Omokanye (2011) study, and this could be why forage DM yield was generally higher in the present study. Both P8107HR and 39FV05corn hybrids had higher CHUs than other corn hybrids, an indication that these hybrids may not be suited for this environment.Three (P8107HR, X70B144R1 and 39FV05) of the 9 corn hybrids with <8.0 t ha^{-1} forage DM yield and German millet with the lowestforage DM yield wouldn't be suggested for silage or grazing in this environment. In Table 2, the millets and CFSH 30had significantly higher crude protein (CP) than corn hybrids as well as the controls. The forage CP generally varied 8.15% for 39F44 corn hybrid to 14.8% for German millet. I observed that German millet did not flower throughout the growing season and that probably explains why it had the highest CP content, as it was very green and still in the active vegetative growth stage when it was harvested.Protein is a building block and the beef cow rule of thumb with protein is 7-9-11, which means an average mature beef cow (weighing 544 kg) requires a ration with crude protein of 7% in mid pregnancy, 9% in late pregnancy and 11% after calving (NRC, 2000). Looking at Table 2, all crops tested had adequate protein for a dry gestating cow in the mid pregnancy stage, but 2 of the 14 crops tested fell short of meeting the 9% protein that is required by a cow in the late pregnancy stage. For a nursing or lactating cow, only Red proso millet, German millet and CFSH 30 had sufficient protein for this category of cow. The forage Ca, P, K and Mg respectively varied from 0.21-0.40%, 0.11-0.29%, 0.96-2.82% and 0.09-0.47%. All crops had adequate Ca for a dry gestating cow (which requires 0.18% Ca), but all crops fell short of meeting the Ca requirement of a lactating cow that requires 0.42%(NRC, 2000). Of the 14 crops tested, only 2 (Red proso and German millets) had enough P in the forage to meet the needs of a mature beef cow(NRC, 2000). All crops exceeded the K requirements of a mature beef cow (0.6-0.7% K), while only 5 crops were able to meet the amount of Mg needed by a mature beef cow (0.12-0.20% Mg) (NRC, 2000). One of the controls (CDC SO-1 oat) mostly ranked first in terms of ADF and NDF content. CDC SO-I oat had significantly lower ADFand NDF than other crops. The ADF value refers to the cell wall portions of the forage that are made up of cellulose and lignin. These values are important because they relate to the ability of an animal to digest the forage. As ADF increases the ability to digest or the digestibility of the forage decreases. The NDF value is the total cell wall which is comprised of the ADF fraction plus hemicellulose. NDF values are important because they reflect the amount of forage the animal can consume. As NDF percent increases, the dry matter intake generally decreases. The forage energy (total digestible nutrients, TDN) varied significantly from 56.7 % for Red proso millet to 63.9% for 36F60 corn hybrid. The TDN was mostly >60.0% for the crops tested. Energy gives the ability to use the building blocks for growth and other productive purposes. The NRC (2000) recommends 49-54% TDN for a dry gestating beef cow (weighing 544 kg) and 57-62% TDN for a nursing beef cow (with 544 kg weight). Looking at Table 2, all crops tested appeared to have sufficient energy for these stages of a mature beef cow. In conclusion, the fewer CHUs corn hybrids should mostly fare better for high forage yield in the PC region. Other warm season crops like Red proso millet and Forage sorghum (CFSH 30) can also provide a high-yielding alternative to oat, which can be utilized for green feed, silage and swath grazing. Results of TDN in this study confirm the fact that warm season cereals tested here have high enough nutritive value to meet (and in most cases even exceed) the energy requirements of a beef cow in mid pregnancy through late pregnancy and even after calving in parts of the PC region of Alberta, Canada.

REFERENCES

Baron, V. S., Najda, H. G., McCartney, D. H., Bjorge, M. and Lastiwka, G. W. (2003). Winter weathering effects on corn grown for grazing in a short-season area. *Can. J. Plant Sci.* 83: 333–341.

CoStat.(2005). CoStat program, version 6.4. CoHort Software, Monterey, CA., USA. Government of Alberta. (2012). Agriculture/Peace Country. Retrieved December 15, 2012, from http://www.albertacanada.com/business/statistics/peace-country-agriculture.aspx

McCartney, D., Basarab, J. A., Okine, E. K. Baron, V. S. and Depalme, A. J. (2004). Alternative fall and winter feeding systems for spring calving cows. *Can. J. Anim. Sci.* 84: 511–522.

NRC (National Research Council). (2000). Nutrient Requirements of Beef Cattle(7th rev. ed.). Update 2000.Washington, DC: The National Academies Press.

Omokanye, A.T. (2011).Evaluation of Corn Varieties for Grazing In Northern Alberta. Proceedings of the ASA, CSSA and SSSA Annual Meetings (San Antonio, TX, USA - Oct. 16-19, 2011). http://a-c-s.confex.com/crops/2011am/webprogram/Paper65110.html.

Table 1. Corn heat Unit (CHU), rainfall, maximum (Max.) and minimum (Min.) air temperature (temp.) in the crop growing months for 2012 and their long-term averages (LTA) at Fairview, Alberta, Canada

	CHU		Rainfall, mm		Max. temp. °C		Min. temp. °C	
Month	2012	LTA	2012	LTA	2012	LTA	2012	LTA
May	166	127	9.4	40.2	18.3	16.2	4.8	3.3
June	567	552	154.6	105.3	18.8	20.1	7.7	7.7
July	1045	1109	102.1	175.6	19.5	21.9	9.0	9.6
August	1540	1603	26.31	223.5	20.2	21.0	7.0	8.2
September	1931	1866	20.0	256.6	17.3	15.7	4.7	3.6

Table 2. Crops tested & their moisture content at harvest (Moist.), forage DM &forage nutritive value.

Crop	CHU[Z]	Moist %	DM Kg/ha	CP %	Ca %	P %	K %	Mg %	ADF %	NDF %	TDN %
P7213R corn	2050	74.9	9250	10.2	0.27	0.11	1.88	0.13	34.6	55.0	62.2
39F44 corn	2000	77.8	9119	8.15	0.33	0.17	1.56	0.18	33.2	58.4	63.0
P8107HR corn	2350	75.9	7279	9.48	0.33	0.16	1.90	0.09	38.7	63.1	59.8
X70B140R corn	2000	77.8	8197	8.26	0.40	0.17	1.80	0.17	35.2	63.4	61.8
P7443R corn	2100	73.8	8383	9.37	0.35	0.13	1.71	0.19	33.9	61.5	62.6
X70B144R1 corn	2000	74.2	6036	9.46	0.40	0.19	1.73	0.12	34.4	62.0	62.3
39M26 corn	2100	74.8	11529	9.47	0.37	0.14	1.63	0.15	35.0	61.7	62.0
36F60 corn	2250	74.1	10661	9.84	0.31	0.11	1.61	0.18	32.0	56.4	63.9
39FV05 corn	2350	75.8	7349	10.0	0.33	0.12	1.63	0.23	34.0	59.6	62.5
Red proso millet	-	71.7	5115	13.4	0.22	0.29	2.82	0.13	43.1	65.5	56.7
German millet	-	75.2	3878	14.8	0.39	0.27	1.78	0.47	42.7	61.7	56.8
CFSH 30 (FS)	-	76.2	5263	13.8	0.26	0.23	1.86	0.39	39.6	65.0	58.4
CDC Baler oat (C)	NA	65.9	6544	9.59	0.21	0.17	0.96	0.20	33.3	53.5	61.6
CDC SO-I oat (C)	NA	65.0	5134	10.1	0.30	0.17	1.17	0.28	30.9	51.0	62.7
Significance[X]	*NA*	*	*	*	*	*	*	*	*	*	*
$LSD_{0.05}$	*NA*	*0.78*	*982*	*1.37*	*0.01*	*0.01*	*1.61*	*0.01*	*0.22*	*0.36*	*0.24*
CV[Y], %	*NA*	*4.91*	*16.4*	*6.16*	*3.93*	*4.29*	*5.11*	*7.22*	*2.85*	*2.80*	*3.76*

NA, Not applicable. [Z] CHU, corn heat unit. [Y] CV, coefficient of variation. [X] significant at $P<0.05$.
FS indicates forage sorghum. C indicates control. $LSD_{0.05}$, least significant difference at $P<0.05$.