Determine the Swath Grazing and Forage Quality Potential of Westford Forage Barley and Manta and German Foxtail Millet for Beef Cattle in Southwest Saskatchewan.

A.D. Iwaasa[1], E. Birkedal[1] and T. Lennox[2].

[1]Agriculture and Agri-Food Canada - Semiarid Prairie Agricultural Research Centre (AAFC-SPARC), Box 1030, Swift Current, SK, Canada, S9H 3X2, Iwaasa@em.agr.ca
[2]Saskatchewan Agriculture Food and Rural Revitalization, Swift Current, SK, Canada.

Key Words: Westford barley, Manta, German, foxtail millet, swath grazing, beef cattle.

Abstract

The drought and poor moisture conditions experienced throughout Saskatchewan has revealed the potential that certain foxtail millets can play as an important short-season hay or grazing resource. The study's objectives were to 1) determine the swath grazing performance of cow/calf pairs on Westford barley (WB) (*Hordeum vulgare*), and on two foxtail millets (*Setaria italica*), German (G) and Manta (M); 2) determine the forage quality composition of the WB and millets at different stages of maturities and during field curing. In 2002, the WB and the two millets were each seeded into a 2.2 acre field and each cereal treatment was replicated twice (n = 6). Seeding rate for the WB and millets were 80 and 12 lbs per acre, respectively. In 2003, all cereals were once again seeded into the same fields. In 2002, the WB was swathed at the soft dough stage and the G and M were at the boot and heading stage of maturity, respectively. Eight cow/calf pairs were used to graze each of the G and M pastures, but the WB forage material spoiled before cattle could graze. Poor moisture conditions experienced in the summer of 2003 produced little WB and millet growth, thus no grazing data was collected. 2002 results found higher % ADF and NDF and lower % CP and OMD for the millets compared to the WB. Animal performance (i.e., ADG, TLP etc.) did not differ (P>0.10) between the two millets. Calves gained between 1.8 to 1.9 lbs per day while on the millet pastures; however cows on average lost weight. Forage quality (i.e., OMD and CP) of the two millet swaths did not change 32 days post harvest even though the swaths were rained on. Although the millets show excellent forage and grazing potential in 2002 the poor performance of the millets in 2003 reveals the need for longer grazing and forage research to be conducted to truly evaluate their overall potential for southwest Saskatchewan.

Introduction

The 2001 drought in southwest Saskatchewan showed the importance that annual cereals can play as an emergency forage resource, while other perennial forage production can be limited and non-productive. Spring seeded cool season cereals such as oats, triticale, wheat and barley have been used as an alternative forage resource to aid producers with forage deficit concerns. Westford barley (WB)(*Hordeum vulgare*) is a six-row hooded awnless barley cultivar that was specifically developed for forage utilization by the Western Plant Breeders of Bozeman, Montana. Westford has been reported to have better yields compared to other awnless barley cultivars (i.e., Horsford and Haybet) developed in United States (US). Westford matures considerably later than other US forage barleys which allows for greater forage production. Cash (2003) recommended that the best stage of maturity to harvest the forage barleys is at the milk to early dough stage. Forage quality of WB is considered good for backgrounding and for maintenance cattle diets.

Foxtail millet (*Setaria italica*) is grown primarily for a short-season emergency hay crop and planting of foxtail millet can be delayed until mid-June into July. Foxtail millets have low seedling vigour and in general are poor competitors with weeds. Millet is often considered a drought resistant crop but it is more correctly a fast maturing crop that develops very quickly and utilizes any moisture stored in the relatively shallow soil layers. Harvesting foxtail millet for hay occurs best in the late boot to early bloom growth stages. Any delay after full head emergence will reduce quality; bristles become hard as maturity approaches which may cause sore mouth, lump jaw and eye infections when fed to livestock. Foxtail millet is considered palatable and provides a high quality feed stuff for ruminant animals and several varieties are available. German (G) millet has thicker stems and broader leaves than Siberian millet and requires better management to produce good quality hay. Siberian millet has medium size stems and better drought tolerance. Manta (M) millet was developed in South Dakota and was selected from early Siberian millet that matured about two weeks earlier than G. Generally, millet is not recommended for pasture grazing except in emergency situations since plants do not root well, are easily uprooted by grazing animals and re-growth after grazing is slow, especially if moisture relationships are not optimum (Manske and Nelson 1995; Gregoire 1999a).

Swath grazing is a management tool that has grown in popularity with cattle producers in western Canada. Swath grazing involves cutting an annual or perennial crop sometime in the season and allowing the crop to remain in swath. The major advantages of swath grazing are that it allows livestock to obtain all or part of their feed out in the swath pasture area and reduces feed costs and environmental concerns (i.e., manure and feed handling). Although the major benefit to swath grazing may be during the late fall and winter period, another option may be to utilize annual cereals as an important swath forage resource during the midsummer slump period (late July-September) when many of our tame pasture production and forage quality declines. In addition, the use of annual cereals during drought conditions can be an excellent way to reduce the grazing pressure on permanent perennial pastures and provide additional forage to maintain or extend the grazing season. For swath grazing to be successful, good management principles are needed to achieve maximum use of the crop.

Objectives

To determine cow/calf performance (i.e., average daily gains, grazing days per hectare and total live weight production) from swath grazing WB and G and M foxtail millets; and to determine the forage quality composition of WB and G and M foxtail millets at different stages of maturities and forage quality losses during field curing.

Materials and Methods

A completely randomized design using three annual cereal treatments were evaluated for grazing potential [WB (*Hordeum vulgare*) a cool season C_3 cereal and two foxtail millets (*Setaria italica*), G and M both warm season C_4 cereals]. A total of six paddocks, each 2.16 ac (0.9 ha) in size, were utilized with each treatment replicated twice. In 2002 and 2003, the WB prior to seeding was treated with Raxil FL (fungicide by Gustafson) to prevent loose smut. In 2002 the cool and warm season annuals were all seeded on May 21. In 2003, the millets were seeded (May 17) about two and half weeks earlier than the WB (June 5) so that forage material could be harvested at similar stages of physiological maturity among the cool and warm annuals. In 2002 and 2003, the WB was seeded at 80 lb ac^{-1} (90 kg ha^{-1}) and the two foxtail millets were seeded at 12 lb ac^{-1} (13.4 kg ha^{-1}). In 2002, all the annual cereals were seeded into barley stubble to conserve soil moisture. In 2003, the WB and millets were seeded into barley and millet stubble, respectively. In both years the seeding was done using a Flexicoil air seeder (9" row spacing). Seeding depth for the barley was about 2 in (5 cm) while the millets were seeded at a depth of about 0.5-0.75 in (1.25-1.9 cm). Fertilizer was applied at a rate of 50 lbs ac^{-1} of 11-51-00 to all seeded paddocks. In 2002, the soil nitrogen (N) level in the top 2 ft (60 cm) of the soil was about 89-120 lb ac^{-1} (100-135 kg ha^{-1}), while in 2003, N fertilizer was applied so that about 100 lb ac^{-1} (112 kg $ha^{-1)}$ of N would be available in the top 60 cm. Millet has low seedling vigour and is a poor weed competitor; therefore, in 2002 and 2003, all the seeded pastures were sprayed with a 2-4D amine 600 herbicide at a rate of 0.35 L ac^{-1} for weed control.

In 2002 and 2003, forage quality and available yields (i.e., 0.25 m^2 quadrate measurements) were planned to be measured at different stages of maturities (e.g., vegetative, boot, heading and soft dough) throughout the growing season and up to the time the three cereals were swathed. This was accomplished in 2002, however, the poor moisture and high temperatures received in July and August of 2003 greatly affected forage yields and much of the study was discontinued. Forage quality analyses were done on the stand sward and the harvested forage material (swath) for the following: organic matter (OM) organic matter digestibility (OMD), acid detergent fibre (ADF), neutral detergent fibre (NDF), crude protein (CP), mineral content (P and K) and nitrate-N (NO_3-N). Soil samples were taken on all six paddocks in the spring of 2002 and 2003 to assess soil fertility needs.

In 2002, all three cereals were swathed down using a 14 foot Massey swather. The WB was swathed down on July 25, 2002 at the soft dough stage of maturity but due to the high amounts of precipitation received in July and August the barley forage material molded and was unsuitable for grazing. The WB swaths were baled on August 22 and the forage material removed to allow potential re-growth. The G and M millets were swathed on August 26 at the boot and heading stage of maturity, respectively. Eight cow/calf pairs were placed on each foxtail millet paddock. The amount of swath forage material allocated to each cattle herd was restricted using a single portable electric wire. Therefore, each cattle herd only had access to a certain portion of the paddock to graze which ensured minimum wastage. Once the swaths were cleaned up the electric wire was moved down the paddock field to allow access to fresh swaths. The amounts of wastage or lost forage material from the grazed swaths were estimated prior to allowing the cattle access to new fresh swaths. The amount of available forage material provided during each move was based on assuming the cattle would consume about 3 to 4% of their body weight per day, taking into account feed wastage (trampling and fouling effects). To address potential weathering and deterioration effects on swathed cereals, the swaths for each cereal were randomly sampled at the time of harvest and at different dates post harvest before the cow/calf cattle were allowed access to new swaths. Commercial crossbred Angus-Hereford (red baldy) cows with Red Angus sired calves were used on this study. Cow/calf pairs were weighed at the beginning, middle and end of the swath grazing period. The initial and final animal weights were determined by weighing individual animals on two consecutive days and averaging the weights to minimize variability due to gut fill. Cattle performances [average daily gain (ADG), total live weight production (TLP) and grazing days (GDs)] were determined for each annual cereal treatment.

The experimental design was completely randomized and treatment effects (WB, G millet and M millet) were analysed using the GLM procedure of SAS Institute, Inc. (1996). Means were separated, where applicable, by the protected Least Significant Difference (LSD) ($P<0.05$) test of the GLM procedure (SAS Institute Inc. 1996) unless otherwise stated.

Results and Discussions

Based on the literature available it was assumed that the first cereal to reach the heading stage would be the WB, followed by M and then G foxtail millet. The study in 2002 generally observed those results, however even 90+ d post seeding the G millet stand was mostly at the boot stage. Explanations for G millet not growing and maturing as quickly as expected may be caused by G millet being more sensitive to the lower temperatures observed this spring and the high moisture received in the summer promoting continual growth. It was observed that the G millet stayed in the vegetative form (flag to boot stages) much longer than M. Therefore, the M millet may have more potential as a hay forage (great biomass at the time of harvesting) sooner than the G millet.

Forage quality and production

As expected higher ADF and NDF values and lower CP and OMD values were observed in 2002 for the warm season millets compared to the cool season WB (Table 1.). At the flag leaf stage, forage yields and NDF values were lower ($P<0.05$) and OMD and CP were higher ($P<0.01$) for WB compared to both millets (Table 1.). The observed differences in forage qualities and DM yields can be explained due to differences in growth and fibre composition between warm and cool season forages. Forage qualities and DM yields were similar between the two millets when harvested at the flag leaf stage. At the boot stage, forage qualities and DM yields did not differ ($P>0.08$) between the two foxtail millets (Table 1). In agreement, studies from North Dakota have reported similar DM yields between G and M foxtail millet (Gregoire 1999b). Although DM yields between the two foxtail millets were not significantly different, the numeric difference between the two was large and therefore meaningful. At the heading stage, higher ($P<0.05$) OMD and numerically higher CP values were observed for Westford vs. M (Table 1). As expected, ADF and NDF values for WB were lower ($P<0.05$) than the warm season M millet. Although DM yields between WB and M were not significantly different, the numeric difference between the two was large and therefore meaningful. The observed M DM yield was similar to those reported by other studies in North Dakota (Gregorire 1999b).

Table 1. 2002 and 2003 Average Forage Compositions for Two Foxtail Millets (German and Manta) and Westford Barley at Different Stages of Plant Maturities.[1]

Year and cereal	Plant stage	%OM	%OMD	%ADF	%NDF	%CP	%P	%K	%Nitrate	Yields lb ac^{-1} (kg ha^{-1})
2002										
Barley	Flag[2]	84.3	76.1b	23.6	39.8a	27.8b	0.5b	4.3	0.27	1209a (1355)
	Heading[3]	88.5	66.3c	26.5c	47.0c	15.6	0.4d	3.3	0.14	3796 (4256)
	Dough	88.9	65.0	25.3	45.5	16.6	0.4	3.3	0.16	3504 (3928)
German	Flag	87.0	70.8a	27.1	50.2b	12.3a	0.3a	5.2	0.06	2134b (2390)
	Boot	87.6	64.9	30.2	54.9	11.6	0.3	4.0	0.04	4221 (4732)
Manta	Flag	87.5	70.0a	27.1	50.2b	13.8a	0.3a	4.8	0.07	2095b (2346)
	Boot	89.2	62.8	29.8	56.5	11.5	0.3	3.5	0.04	3111 (3484)
	Heading	89.0	56.3d	30.3d	55.5d	10.7	0.3c	2.5	0.02	5469 (6131)
2003										
Barley	Flag	88.0	71.5	22.6	41.4	23.5	0.3	4.2	NA	973 (1091)
	Heading	91.0	63.6	23.5	45.4	14.4	0.2	2.7	NA	1455 (1631)
	Dough	90.8	63.4	24.7	48.9	14.2	0.2	2.8	NA	1266 (1420)
German	Flag	89.7	69.8	20.4	47.2	14.9	0.2	3.9	NA	565 (633)
	Boot	90.6	68.1	21.6	51.4	14.0	0.2	3.2	NA	350 (392)
Manta	Flag	90.9	68.7	20.6	47.3	15.0	0.2	3.4	NA	604 (678)
	Boot	91.4	66.2	21.2	50.1	13.2	0.2	3.0	NA	516 (578)

[1]OM = organic matter; OMD = organic matter digestibility; ADF = acid detergent fibre; NDF = neutral detergent fibre; CP = crude protein; P = phosphorus; K = potassium; and Nitrate = NO_3-N

[2]a-b Means within a column and stage of maturity at flag with different letters are significantly different ($P<0.05$).

[3]c-d Means within a column and stage of maturity at heading with different letters are significantly different ($P<0.05$).

Unfortunately, the 2003 study was dramatically affected by the hot and dry conditions experienced in July and August. As a result of the drought conditions forage production values were greatly reduced and the animal swath grazing part of the study did not occur (Table 1).

Grazing performance and animal health

The forage condition (i.e., become moldy and blacken) of WB declined rapidly due to the rainy weather conditions experiences in July and August of 2002. Therefore, animal grazing and forage quality measurements on the WB were not available. Animal performance (i.e., ADG, TLP and GDs) did not differ (P>0.10) between the two millets (Table 2). The calves gained between 1.8-1.9 lb d^{-1} (0.84-0.86 kg d^{-1}) while on the different millet pastures, however, the cows on average lost weight over the 22 days. Milk production by beef cows usually declines 3 to 4 months following calving and forage intake by calves increases with decreasing milk consumption (Baker et al. 1976), thus it is plausible that much of the gains in the calves were from grazing the millet and not from milk consumption. Throughout the study we observed the calves and cows grazing on the swath millets with no difficulty (Fig. 1). This is further supported by the excellent percent utilization of the swath material for both millets (e.g., ranging from 78 to 85%). Although it is not unusual for cow weights to decline while with a calf on pasture it is important that the weight lost is not large enough to detrimentally affect the cow's body condition and be unprepared for the winter feeding period (mid-gestation period). For the period of time the cows were on pasture their body condition score was not observed to change. Higher swath utilization (i.e., 90%) and grazing days (i.e., 318 d ha^{-1}) were reported for cows grazing G millet swaths near Canora Saskatchewan (Personal communication Vanin 2002). However, results from our study were comparable and showed that swath grazing of millet can provide an important grazing forage resource and additional grazing days to extend the grazing season in southwest Saskatchewan. Growing and grazing millet as an emergency forage resource is often considered during a drought or poor moisture situation. Two compounds that can accumulate in millet during a drought are nitrate-N and prussic acid. In this study, due to the abundant moisture of 2002, both millets had nitrate-N levels that were not a concern at any stage of maturity (Table 1). Unfortunately, prussic acid levels were not tested in this study, but generally, foxtail millets have very low levels of cyanide and therefore, prussic acid or hydrocyanic acid poisoning is rare (Lardy 2002). However, when grazing millet it is a good idea to have your forage tested for nitrate-N and prussic acid levels.

Table 2. Swath Grazing Performance of Cow/Calf Pairs on Manta and German Millets in 2002.[1]

Foxtail millets and grazing animals	Average daily gains, lb d^{-1} (kg d^{-1})	Total live weight production, lb d^{-1} (kg d^{-1})	Grazing days, d ac^{-1} (d ha^{-1})
Manta (Red Siberian)			
Calf	1.8 (0.84)	159.3 (185.8)	88.5 (221.2)
Cow	-3.2 (-1.48)	-283.2 (-327.4)	
German (Golden)			
Calf	1.9 (0.86)	168.2 (190.2)	88.5 (221.2)
Cow	-3.2 (-1.46)	-283.2 (-323.0)	

[1]Total live weight production = average daily gain x grazing days per acre (Schellenberg et al. 1999) and grazing days ac^{-1} = (total number of animals x number of days on test)/area.

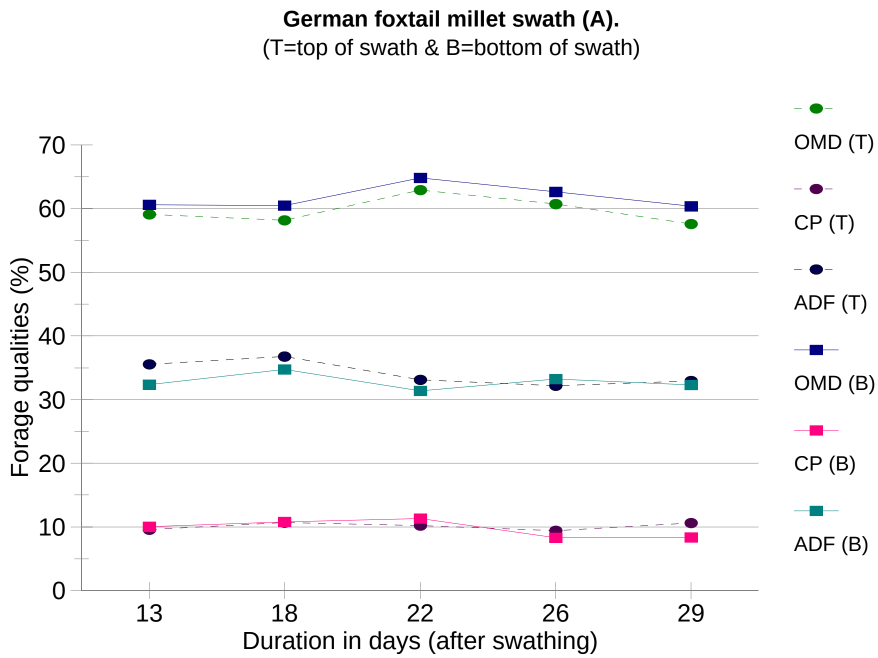
Figure 1. Beef cattle grazing foxtail millet in 2002.

Sward forage composition

It is recognized that effects of weathering can significantly affect the forage quality of the swath millet (AAFRD 2001). Results found that OMD and CP values did not differ (P>0.12) among the five sampling dates for forage material sampled from either the top or the bottom of the swath (Fig. 2). Therefore, good forage quality was maintained in the swath for up to 29 days post harvest, for both G and M millets even though some precipitation was received on the swaths. Normally, much of the annual precipitation in southwest Saskatchewan is received in May, June, July and some in August. Therefore, based on the preliminary results of this study the swath forage qualities of G and M millet should not decline very much during the months of August and September. In agreement, a swath grazing demonstration study in Canora Saskatchewan reported that the loss in feed value for forage lying in the swath from August 23 to October 30, 2002 was very small (Personal communication Vanin 2002). The epicuticular wax on stems and leaves found on warm season forages, such as G and M millets, may resist weathering and therefore explain why these millets are able to maintain their forage quality while in the swath (Simpson 1981). Small differences in ADF values among sampling dates were observed for M forage material taken from the bottom (P<0.05) of the swath and for G forage material taken from the top (P=0.05) of the swath. However, these differences are more likely due to sampling errors. In all cases, ADF values did not consistently increase over sampling dates.

Conclusions

As expected the WB was the first to reach the heading stage followed by M. The G millet did not reach the heading stage even by 90 days post seeding. Results found that forage qualities between the two millets were similar at the flag and boot stage of maturities and that both millets have the potential to produce excellent forage DM yields. Both millets were grazed similarly by the cattle and resulted in similar animal gains and performance. Therefore, both foxtail millets can be swathed grazed and provide an important forage resource, as well as additional grazing days to extend the grazing season in southwest Saskatchewan. Even though the two millets were swathed down at different stages of maturities (heading vs. boot stages) the millet swaths were able to maintain their quality even after receiving substantial precipitation. Further research is needed to determine the ability of the millets and WB cereals to provide consistent forage yield over various environmental conditions and years.



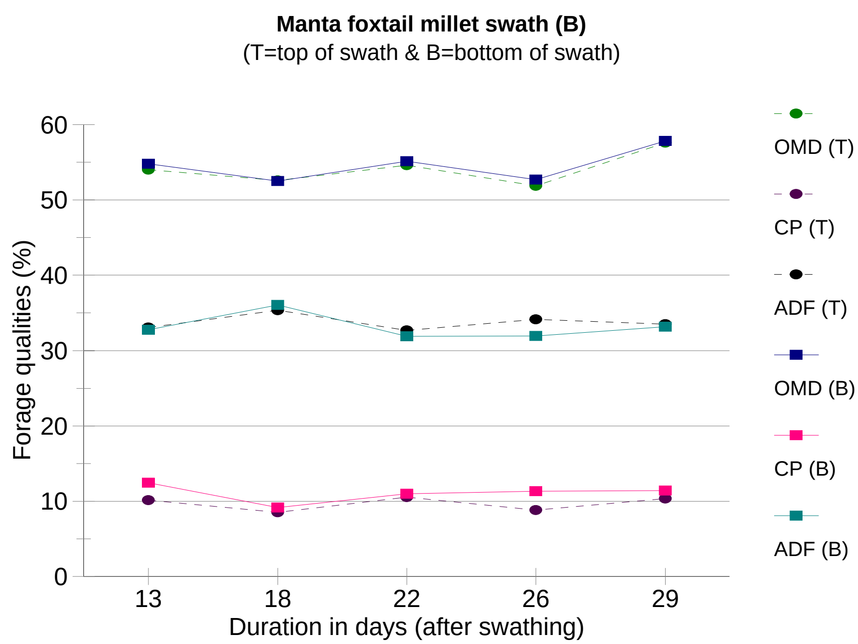


Figure 2. Swath characteristics of German (A) and Manta (B) foxtail millet sampled 13 to 29 days post harvested (i.e., swathed down) (OMD=organic matter digestibility, CP=crude protein and ADF=acid detergent fibre).

Acknowledgments

This project would not have been possible without funding support from Saskatchewan Agriculture Food and Rural Revitalization, Southwest Forage Association, Saskatchewan Horn Cattle Purchase Fund and Heartland Livestock Inc. We thank R. Wall and S. Grant for their help with data collection and T. Lennox with SAFRR for his support and assistance in the project.

References

Alberta Agriculture, Food and Rural Development. 2001 Cattle Nutrition Course. AAFRD 3rd ed. 2001.

Baker, R.D., Ledu, Y.L.P. and Barker, J.M. 1976. Milk-fed calves. I. The effect of milk intake upon the herbage intake and performance of grazing calves. J. Agr. Sci., (Camb.) 87:187-196.

Cash, D. 2003. Forage alternatives for drought conditions. Http:waterquality.montana.edu/docs/irrigation/droughtforage.shtml.

Gregoire, T. 1999a. Grazing foxtail millet. Http://www.ag.ndsu.nodak.edu/aginfo/procrop/mil/milplt05.htm

Gregoire, T. 1999b. ProCrop 1999 - crop production database. Http://www.ag.ndsu.nodak.edu/aginfo/procrop/hay/annfor06.htm.

Lardy, G. 2002. Prussic acid poisoning a concern when feeding emergency forages. Http:/www.ext.nodak.edu/extnews/newsrelease/2002/070402/19prussi.htm.

Manske, L.L. and Nelson, J. 1995. Grazing annual forages on cropland in western North Dakota. Http://www.ag.ndsu.nodak.edu/dickinso/research/1995/grass95c.htm.

SAS Institute, Inc. 1996. SAS/STAT user's guide. (Release 6.12). SAS Institute, Inc., Cary, NC.

Schellenberg, M.P., Holt, N.W.and Waddington, J. Effects of grazing dates on forage and beef production of mixed prairie rangeland. Can. J. Anim. Sci. **79:** 335-341.

Simpson, G.M. 1981. Water stress on plants. Praeger Publ., New York, USA.