In Situ Ruminal Kinetics of Dry Matter and Neutral Detergent Fiber Disappearance for the Biomass Forages Amur Silvergrass and Big Bluestem


Story in Brief

Alternative strategies, such as grazing, could minimize economic risk associated with biomass production. Minimal research is available that describes the nutritive value of biomass forages, specifically Amur silvergrass (AS; Miscanthus sacchariflorus (Maxim.) Benth., proprietary clone Msanag). Four ruminally-cannulated steers were used to determine ruminal in situ disappearance kinetics of DM and NDF for AS and ‘Hampton’ big bluestem (BB; Andropogon gerardii Vitman) harvested at vegetative growth stage on three dates (4 June, 8 July, and 31 July) in west-central Arkansas. Crude protein was greater (P < 0.01) on 4 June (13.0%) than either 8 July (9.5%) or 31 July (9.5%) for both forages, and similar (P = 0.84) for forage type across sampling dates. Neutral detergent fiber was greater (P = 0.03) for AS (72.8%) compared to BB (69.3%). A sampling date × forage type interaction influenced (P < 0.02) rate (Kd) of DM; rate of disappearance (Kd/h) of DM was slowest for AS harvested on 8 July as well as both forages on 31 July. Effective DM degradability tended to be greater for BB on 8 July (56.5%) and 4 June (55.6%) sampling dates and least for AS on all three sampling dates (mean = 39.1%). As observed for disappearance of DM, Kd for NDF disappearance was slower (P < 0.02) for AS than BB. Effective NDF degradability was greater (P < 0.01) for BB (42.5%) than AS (28.9%). It appears that AS has adequate nutritive value during the early summer, and livestock grazing of AS could be an alternative to biomass production.

Introduction

In his State of the Union Address in 2006, President Bush specifically targeted alternative sources for ethanol production, specifically switchgrass. Currently, the U.S. produces approximately 750 billion dry pounds per year of biomass from perennial crops. The main uses for these biofuel forages are ethanol production and combustion.

Alternative strategies, such as grazing, could minimize the economic risk associated with biomass production; however, minimal research is available that describes the nutritive value of many of the biomass forages. Miscanthus is a C4 grass native to Asia commonly used as an ornamental in the U.S. (Sanderson and Adler, 2008). Heaton et al. (2004) reported Miscanthus could yield twice as much biomass compared with switchgrass. Objectives of this study were to determine ruminal in situ disappearance kinetics of dry matter (DM) and neutral detergent fiber (NDF) of Amur Silvergrass (AS; Miscanthus sacchariflorus (Maxim.) Benth., proprietary clone Msanag) and ‘Hampton’ Big Bluestem (BB; Andropogon gerardii Vitman).

Experimental Procedures

Experimental Forages. The AS and BB were harvested in the vegetative growth stage on three dates (June 4, July 8, and July 31) in west-central Arkansas. Samples were randomly taken across three replicates of each forage and oven-dried at 133°F for 48 h, then ground to pass through a 2-mm screen in a Wiley Mill.

In situ procedures. Four ruminally-cannulated steers (752 ± 40 lb) were utilized to evaluate the in situ disappearance kinetics. Steers were adapted (2.25% of BW) to a basal diet of cracked corn and common bermudagrass hay (15:85 ratio of corn:hay) for 10 d prior to the trial and were allowed ad libitum access to fresh water. Approximately 2-ounce (5 g) samples of each forage were weighed and placed into 4 × 8 inch Dacron bags. Dacron bags for each time period were placed in 14 × 18 inch mesh laundry bags and incubated in tepid water (102°F) for 20 min before being placed in the ventral rumen. Mesh bags were incubated in the rumen for 3, 6, 9, 12, 24, 36, 48, 72, and 96 h. Following removal from the rumen, bags were rinsed in a top-loading washing machine. The 0 hour bags were rinsed immediately following incubation in tepid water for 20 min. After rinsing, samples were dried at 133°F for 48 h until a constant weight.

Statistics. Disappearance kinetics was calculated by nonlinear regression of the percentage of DM and NDF remaining on incubation time using the PROCNLIN procedure of SAS. A randomized complete block design with a 2 × 3 factorial arrangement of treatments using the MIXED procedure of SAS with steers representing the blocking term was used to analyze in situ disappearance kinetics. Least squares means were separated using PDIF statement of SAS when protected by a significant (P < 0.05) treatment effect. Fraction A was defined as the immediately soluble fraction. Fraction B represented that portion

1 Names are necessary to report factually on available data; however, the USDA does not guarantee or warrant the standard of the product, and the use of the name by the USDA implies no approval of the product to the exclusion of others that also may be suitable.
2 Morehead State University, Morehead, Ky.
3 University of Arkansas, Department of Animal Science, Fayetteville, Ark.
4 University of Arkansas for Medical Sciences, Little Rock, Ark.
5 USDA-ARS, Small Farms Research Center, Booneville, Ark.
6 University of Tennessee, Martin, Tenn.
7 USDA-NRCS, Booneville, Ark.
8 Bical, Staffordshire, England.
9 USDA-ARS, Marshfield, Wis.
of DM that disappeared at a measurable rate, and fraction C was defined as the portion that was undegraded in the rumen. Fraction B and C, and rate of disappearance ($K_d$) were determined directly from the nonlinear model. Fraction A was calculated as $100 – (B + C)$; similarly, the potential extent of disappearance was calculated as $100 – C$.

### Results and Discussion

Forage type did not influence ($P = 0.84$) CP in the current trial (mean CP = 10.6%; Table 1). Crude protein was greater ($P < 0.01$) on 4 June than 8 July and 31 July for both forages. Neutral detergent fiber was greater ($P = 0.03$) for AS compared to BB (Table 1). Acid detergent fiber tended ($P < 0.07$) to be greater for AS than BB across all sampling dates (Table 1). Dietary CP requirements of a 1,200 lb, mid-gestation cow are 6.9% CP (NRC, 1984). With CP of both forages above 9% during the duration of the trial, if dry matter intake is adequate, either forage could meet the CP requirements of cows.

Fraction A of DM was greater ($P < 0.0001$) in BB (22.1 ± 0.6%) than AS (18.9 ± 0.6%) and greater on 8 July (23.4 ± 0.7%) than 4 June (18.7 ± 0.7%) and 31 July (19.4 ± 0.7%). A sampling date $\times$ forage type interaction tended ($P \leq 0.09$) to influence fractions B and C of DM. A sampling date $\times$ forage type interaction influenced ($P < 0.02$) rate ($K_d$) of DM; rate of disappearance ($K_d/\text{h}$) of DM was slowest for AS harvested on 8 July as well as both forages on 31 July. Rate of DM disappearance was faster for both forages harvested on 4 June (Fig. 1). Effective DM degradability tended ($P = 0.09$) to be lower in AS on all collection dates than BB; BB collected 31 July had lower effective DM degradability than BB collected on 4 June and 8 July (Fig. 2). Effective DM degradability for BB was similar to that reported for bahiagrass and bermudagrass harvested in June in west central Arkansas (Flores et al., 2006). Effective DM degradability for AS was similar to values reported for more mature bahiagrass and bermudagrass harvested in October (Flores et al., 2006).

Rate of NDF disappearance was slower ($P < 0.02$) for AS than BB (Fig. 3). Effective NDF degradability was lower ($P < 0.01$) in AS than BB in the current trial (Fig. 4). Potential extent of NDF disappearance was influenced ($P < 0.04$) by sampling date $\times$ forage type interaction. Potential extent of NDF disappearance was greatest for BB on all three sampling dates and lowest for AS on 8 July and 31 July.

We conclude the rate of disappearance for DM and NDF were slower for AS than BB. Further, the effective DM and NDF degradability were less for AS than BB. One caveat producers should consider with AS is the possibility of rapid spread via rhizomes, and AS could set seed at more southern latitudes.

### Implications

It appears that Amur silvergrass has adequate nutritive value during the early summer, and livestock grazing of AS could be an alternative to biomass production. Future research should include grazing studies to determine both plant and animal performance.

### Literature Cited


### Table 1. Nutritional analysis (DM basis) of Amur silvergrass (AS) and big bluestem (BB) on three harvest dates in west-central Arkansas.

<table>
<thead>
<tr>
<th>Item</th>
<th>4-June</th>
<th>Harvest date</th>
<th>8-July</th>
<th>31-July</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>AS</td>
<td>BB</td>
<td>AS</td>
<td>BB</td>
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<tr>
<td>Crude protein, %$^1$</td>
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<td>Neutral detergent fiber, %$^2$</td>
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<td>71.9</td>
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<td>Acid detergent fiber, %$^3$</td>
<td>35.2</td>
<td>34.4</td>
<td>35.8</td>
<td>31.6</td>
</tr>
</tbody>
</table>

$^1$Date effect, $P < 0.01$.
$^2$Forage effect, $P = 0.03$.
$^3$Forage effect, $P < 0.07$.
Pooled SE = CP ± 0.3%; NDF = 0.8%; and ADF = 0.9%.
Fig. 1. Rate of DM disappearance of big bluestem (BB) and Amur silvergrass (AS); date × forage interaction; date × forage interaction, $^{a,b,c}P < 0.02$.

Fig. 2. Effective DM degradability of big bluestem (BB) and Amur silvergrass (AS); date × forage interaction, $^{a,b,c}P = 0.09$. 
Fig. 3. Rate of NDF disappearance of big bluestem (BB) and Amur silvergrass (AS), $P < 0.02$.

Fig. 4. Effective NDF degradability of big bluestem (BB) and Amur silvergrass (AS), $P < 0.01$. 