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Effect of brachytic dwarf forage sorghum or corn silage harvested in the summer or fall and supplemented with soybean meal or mechanically pressed cottonseed meal on performance of lactating dairy cows

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ABSTRACT

A 6-wk randomized design trial with a 4 × 2 factorial arrangement of treatments was conducted to evaluate the production response of 48 Holstein lactating cows fed diets based on corn or forage sorghum silage harvested in the summer or fall and supplemented with soybean meal (SBM) or mechanically pressed cottonseed meal (CSM). Corn was planted in April and harvested in July (CSS), and a second crop was planted in August and harvested in November (CSF). Forage sorghum was planted in April, harvested in July (FSS), allowed to ratoon, and harvested again in November. Forages provided 41.67% of the dietary DM in the experimental diets, and CSM replaced a portion of the N provided by SBM. Cows were fed a corn silage–based diet for 2 wk before beginning the 4-wk experimental period. No differences were observed in DMI or milk yield among treatments. An interaction of forage source and protein supplement was observed for milk fat, which was lowest for CSF-CSM compared with the other treatments. No differences were observed in yield or concentration of milk protein, lactose, or solids-not-fat. An interaction was observed for efficiency of milk production, which was lowest for CSS-SBM and CSF-CSM compared with the other treatments. Concentrations of milk urea nitrogen were less for diets based on corn silage compared with forage sorghum and for CSM compared with SBM. Results of this trial indicate that diets based on corn silage or forage sorghum harvested in spring or fall and supplemented with CSM or SBM can support similar performance.

Key words: corn silage, forage sorghum, milk yield, mechanically pressed cottonseed meal, soybean meal

INTRODUCTION

Forage sorghum (**FS**) is grown in many areas of the southeastern United States where irrigation is not available or limited, because of its reduced water requirements compared with corn (Miron et al., 2007; Contreras-Govea et al., 2010). However, FS has less starch, resulting in reduced energy concentrations compared with corn (Bean et al., 2005; Bean and McCollum, 2005). Milk yield of lactating dairy cows fed diets based on normal FS compared with tropical corn silage (**CS**) was not different (Nichols et al., 1998) but is typically less than that observed for cows fed diets based on temperate CS (Grant et al., 1995; Aydin et al., 1999; Miron et al., 2007). Forage sorghum varieties with the brown midrib gene (**BMR**) produce forage that has reduced lignin concentrations and greater NDF digestibility (Contreras-Govea et al., 2010) and has been reported to support similar FCM yield as that observed for cows fed CS-based diets (Grant et al., 1995; Aydin et al., 1999; Oliver et al., 2004).

Forage sorghum is very susceptible to lodging. Varieties with the brachytic dwarf gene are shorter (approximately 1.8 m in height versus 3.6+ m) than normal FS and have shorter internodes without affecting the number of leaves, leaf size, maturity, or yield. Yosef et al. (2009) did not observe any difference in the in vitro or in vivo DM digestibility of silage produced from dwarf compared with normal FS hybrids.

In the semi-tropical regions of the southeastern United States, FS can be ratooned to produce a second crop of forage without replanting when FS is planted in early spring. For producers with either limited capacity to irrigate or limited water resources, this system provides an option to increase forage production while using less water for irrigation. Because a second crop would not have to be planted, it also provides an opportunity to reduce total labor and production cost considering increases in fuel and energy cost.

Cottonseed meal (**CSM**) is a by-product of extracting oil from whole cottonseed that is included in rations fed to lactating dairy cows. Compared with soybean meal (**SBM**), the AA quality of CSM is less desirable because of reduced lysine concentrations (4.13 vs. 6.29% of CP, respectively; Bernard, 2011). However, DMI and performance of lactating cows supplemented with CSM or SBM were similar (Brito and Broderick, 2007; Bernard, 2011).

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With increasing demand for oil for biodiesel production, smaller plants that use mechanical press for oil extraction have been built. The resulting CSM has reduced CP and greater NDF and fat concentrations than mechanically extruded CSM (NRC, 1989). Currently there are limited data on the feeding value of mechanically pressed CSM for lactating dairy cows.

The first objective of this trial was to evaluate the feeding value of brachytic dwarf BMR FS silage produced in a system where it is allowed to regrow after the first harvest and harvested a second time compared with 2 CS crops produced during the same period. A second objective was to evaluate the performance of lactating dairy cows fed diets in which CSM was substituted for a portion of the SBM in diets fed to lactating dairy cows.

MATERIALS AND METHODS

Forage Production

Forages were grown in a field with Tifton sandy loam soil on the Animal and Dairy Science farm unit located on the University of Georgia Tifton Campus. Temperate corn (Pioneer P1690YHR, DuPont Pioneer, Johnston, IA Company, St. Louis, MO) was planted on April 10, 2014, at a seeding rate of approximately 79,070 seed/ha. Forage was harvested on July 24, 2014, and ensiled in a 2.4-m plastic bag (Up North Plastics Inc., Cottage Grove, MN) until the beginning of a production trial. The second crop (DeKalb 67–87, Monsanto Company, St. Louis, MO) was planted on July 29, 2014, and managed the same as outlined for the first crop. Corn was harvested on October 30, 2014, and ensiled in a 2.4-m plastic bag.

A brachytic dwarf BMR FS variety (Alta 7401, Alta Seeds, Amarillo, TX) was planted at a seeding rate of approximately 7.85 kg/ha on April 18, 2014. Forage was harvested on August 8, 2014, when the grain had reached the dough stage of maturity and ensiled in a 2.4-m plastic bag until the beginning of a production trial. The crop was fertilized and allowed to regrow and produce a second crop. The forage was harvested on November 6, 2014, at early dough stage of maturity and ensiled in a 2.4-m plastic bag.

First crops of CS and FS were fertilized with 44.7 kg/ha N, 44.7 kg/ha P_2O_5, and 93.4 kg/ha K_2O before planting and top dressed with 154 kg/ha N according to the University of Georgia recommendations based on soil test. The same fertilization program was used for the second crop of corn. The ratoon crop of FS received 73 kg/ha N, 18.3 kg/ha P_2O_5, and 36.6 kg/ha K_2O and was top dressed with 154 kg/ha N. Herbicides were applied according to University of Georgia recommendation and crops were irrigated as needed to maintain soil moisture.

Production Trial

Forty-eight multiparous lactating Holstein cows averaging 140.9 ± 55.9 DIM, 42.6 ± 6.3 kg/d milk, 3.5 ± 0.7% fat, 691.3 ± 73.2 kg of BW, and 3.10 ± 0.19 BCS were used in a 6-wk randomized design trial with a 4 × 2 factorial arrangement of treatments. Cows were trained to eat behind Calan doors (American Calan, Northwood, NH) before beginning the trial. All cows were fed a basal diet based on CS for 2 wk, and data were collected for use as a covariate in the statistical analysis. At the end of the preliminary period, cows were assigned randomly to 1 of 8 treatments by energy-corrected milk (**ECM**) for the following 4 wk. Treatments included 4 forage sources [summer CS (**CSS**), fall CS (**CSF**), summer FS (**FSS**), or regrowth fall FS (**FSF**)] and 2 protein supplements (SBM or CSM).

Diets (Table 1) were formulated to provide equal concentrations of CP, NDF, and NE_l based on preliminary forage analysis and fed as a TMR once daily in amounts to provide a minimum of 5% orts. The amount of feed offered and refused was recorded daily. Samples of dietary ingredients and experimental rations were collected for DM analysis 3 times each week. Rations were adjusted as necessary to account for changes in the DM content of individual ingredients. Individual samples were composited by week and ground to pass through a 1-mm screen using a Wiley mill (Thomas Scientific, Swedesboro, NJ). Forage samples were analyzed for concentrations of DM, ash (AOAC International, 2000), CP (Leco FP-528 Nitrogen Analyzer, St. Joseph, MO), ADF (AOAC International, 2000), NDF corrected for ash (Van Soest et al., 1991), and 30-h NDF digestibility (Goering and Van Soest, 1970). Fermentation end-product concentrations of the silages were determined as described previously (Bernard and Tao, 2015). Samples of experimental diets were analyzed for DM, ash, CP, ADF, (AOAC, 2000), and NDF adjusted for ash (Van Soest et al., 1991) and ether extract (AOAC International, 2000).

Cows were milked 3 times daily at 0700, 1500, and 2300 h and milk yields recorded electronically (Alpro, DeLaval, Kansas City, MO) at each milking. Milk samples were collected from 3 consecutive milkings once each week for analysis of milk fat, protein, lactose, solids-not-fat, and milk urea nitrogen (**MUN**) concentrations by infrared spectrophotometric analysis with a Foss 4000 instrument (Foss North America, Eden Prairie, MN; Dairy One Cooperative, Ithaca, NY).

Individual BW was recorded on 3 consecutive days following the 0700 h milking at the end of the pretrial period and at the end of the experimental period. To minimize variation, BW was recorded immediately after milking before allowing access to feed or water. Body condition scores were assigned by 2 individuals during the last week of the preliminary period and wk 4 of the experimental period (Wildman et al., 1982).

Data from the production trial were analyzed using the PROC MIXED procedure of SAS (SAS Institute Inc., Cary, NC). The model included the effects of covariate; parity; forage source; protein supplement; week; and the interactions of forage source, protein supplement, and week. Cow within forage source and protein supplement