Effects of Harvest Date and Late-Summer Fertilization Rate on Stockpiled Bermudagrass Forage Accumulation and Chemical Composition

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Story in Brief

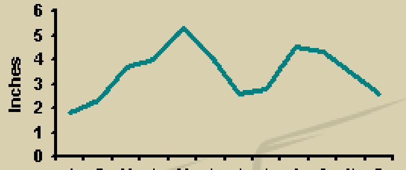
Feeding harvested forages during the winter is expensive for cow-calf producers. Partially wintering cows on stockpiled forage can reduce costs. Our objective was to evaluate effects of harvest date and fertilization rate on bermudagrass (*C. dactylon* L. Pers) biomass accumulation and the chemical composition of the carbohydrate and protein fractions of that biomass. Data were collected for two years at two locations, one each in eastern and central Oklahoma. Late summer fertilization was applied in mid-August at one of four levels (0, 30, 60, 120 lbs N/acre) and samples were harvested monthly beginning in November and continuing through March. Forage accumulation was measured as the amount of forage dry matter stockpiled from mid-August to November. Increasing nitrogen fertilization rate increased forage accumulation during the stockpiling period. Additionally, increasing rates of nitrogen fertilization resulted in improved forage nutritive value. However, overall forage nutritive value tended to decline after January. During the late fall (November through December), stockpiled bermudagrass forage is capable of meeting the energy requirements of spring-calving cows, but energy supplementation may be required after December.

Key Words: Stockpiled Bermudagrass, Forage Quality, Fertilization

Introduction

A large proportion of cow-calf enterprise costs are associated with feeding harvested forages during the late fall and early winter. By extending grazing through late fall and early winter, producers can reduce the amount of harvested forage that is needed to maintain cow performance and therefore reduce enterprise costs. One forage management practice that can be utilized to achieve this goal is the use of stockpiled forages. Bermudagrass has been demonstrated to be successful in stockpiling systems for spring-calving beef cows to reduce winter hay costs (Lalman et al., 2001). Bermudagrass has been successful in a stockpiling system for several reasons including high responsiveness to nitrogen (N) fertilization and adequate fall rainfall for growth (September through November; Figure 1).

Figure 1. Mean monthly precipitation for Haskell, OK



Research has documented that applying N to bermudagrass during the summer growing season can increase forage yield and impact forage chemical composition (Lalman et al., 2000; Johnson et al., 2001). However, limited information is available regarding the impact of late summer N fertilization on forage yield during the stockpiling period and on chemical composition of stockpiled bermudagrass throughout the winter grazing period. Therefore our objective was to evaluate various rates of N application and the impact of fertilization and harvest date on the accumulation and nutritive value of stockpiled bermudagrass during the late fall and winter.

Materials and Methods

This 2-yr experiment was conducted at two locations as a randomized complete block design with four replications. All plots (n=16) at the Eastern Research Station in Haskell, OK consisted of common bermudagrass and were situated on Taloka silt loam soil. All plots (n=16) at the Stillwater Agronomy Research Station in Stillwater, OK consisted of Greenfield bermudagrass and were situated on Norge loam soil. Spring fertilization was applied to all plots at both locations, at the rate of 100 lb N/acre and P and K were applied according to soil test recommendations. Hay was harvested in early June and early August to stage the plots for the experimentation period. Herbicide was applied to maintain a bermudagrass monoculture.

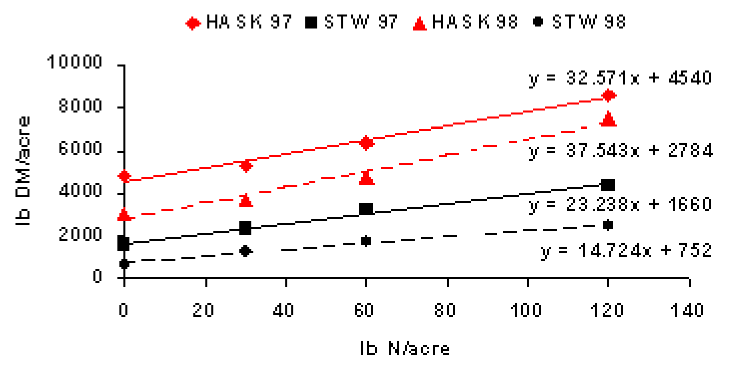
Nitrogen fertilization treatments were applied on approximately August 17 at four levels: 0, 30, 60, and 120 lb N/acre. All plots were harvested at the beginning of each month (November through March). Data were analyzed using least squares analysis of variance and effects in the model included fertilization rate, harvest date, and the interaction. Effects of year, location, and replication were included in the model as random effects. Forage accumulation least squares means were separated using least significant differences. For the chemical composition data, polynomial contrasts were conducted to evaluate the effects of fertilization rate and harvest date.

Forage accumulation was determined as the quantity of forage dry matter that accumulated from August through November and was estimated using a sickle bar mower and calculating the difference in dry matter harvested from a 15 ft x 3 ft strip in August and November. Samples for laboratory analyses were hand-clipped and dried via a forced-air oven (60ºC) and ground. Samples (n=320) were evaluated using near-infrared reflectance spectroscopy (NIRS). Fifteen percent of the samples (n=48) were evaluated using wet chemistry techniques to calibrate equations developed for NIRS. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined using ANKOM technology. Lignin concentration was determined by digesting ADF residue in 72% w/w sulfuric acid for 3 hours. Non-structural carbohydrate (NSC) was calculated as 100 – crude protein – (NDF – NDF bound nitrogen) – ether extract – ash. Total digestible nutrients (TDN) was calculated using the summative equation of Weiss et al. (1992). Crude protein (CP) was determined through via the Kjeldahl procedure. Soluble protein (rapidly degraded fraction) was determined as the disappearance following incubation with a sodium borate-sodium phosphate buffer. Fiber bound protein fractions (that protein bound to the ADF or NDF) were determined by conducting Kjeldahl analysis on the fiber residues. Degradable intake protein was determined from the enzymatic digestion of the sample with the *Streptomyces griseus* enzyme. Protein bound to the ADF fiber fraction was considered the non-degradable fraction. Slowly degraded protein was calculated as the protein bound to the NDF fraction minus the slowly degraded fraction. Moderately degraded protein was calculated as CP – Rapidly Degraded – Slowly Degraded – Non-degraded.

Results and Discussion

Averaged across fertilization treatments and years, Haskell produced approximately 60% more forage DM than Stillwater. Similar divergence between these locations has been reported previously (Wheeler et al., 1998 and 1999; Johnson et al., 2001). Increasing N fertilization resulted in increased forage yields for both years and locations (Figure 2). At Stillwater, forage accumulation increased by 38, 55, and 67% for 30, 60, and 120 lbs N/acre as compared with the negative control. Smaller increases were observed at the Haskell location. Forage accumulation increased by 12, 29, and 51% for 30, 60, and 120 lbs N/acre as compared with the negative control. Regression analysis indicates that for Haskell, each lb N applied per acre results in an increase in forage DM of 33 to 38 lb. This increase is lower at Stillwater, as each lb N applied results in increased forage DM of 15 to 23 lb (Figure 1).

Figure 2. Effect of late summer N fertilization on fall forage accumulation



Fertilization rate influenced TDN, fiber fractions, and NSC (Table 1). Total digestible nutrients and NSC increased linearly with increasing N fertilization rate. In contrast, fiber fractions (NDF and ADF) and lignin decreased linearly with increasing N fertilization. Therefore increasing rates of N fertilization resulted in increased available energy for the animal and decreased the structural carbohydrates as a percentage of forage dry matter. Researchers have reported varying results regarding the effect of N fertilization on the fiber fractions of bermudagrass. Horn et al. (1979) reported no effect of increasing N rate during the summer (60, 180, 300 lbs N/acre) on fiber fractions, however, there was a tendency for a decrease in lignin concentration with increasing N rate. In Florida during the summer, Johnson et al. (2001) observed a decrease in NDF concentration with increasing N rate (0, 35, 70, 105, 140 lbs N/acre).

Table 1. Effect of fertilization rate and harvest date on total digestible nutrients and fiber fractions of stockpiled bermudagrass (expressed as a percent of forage dry matter)

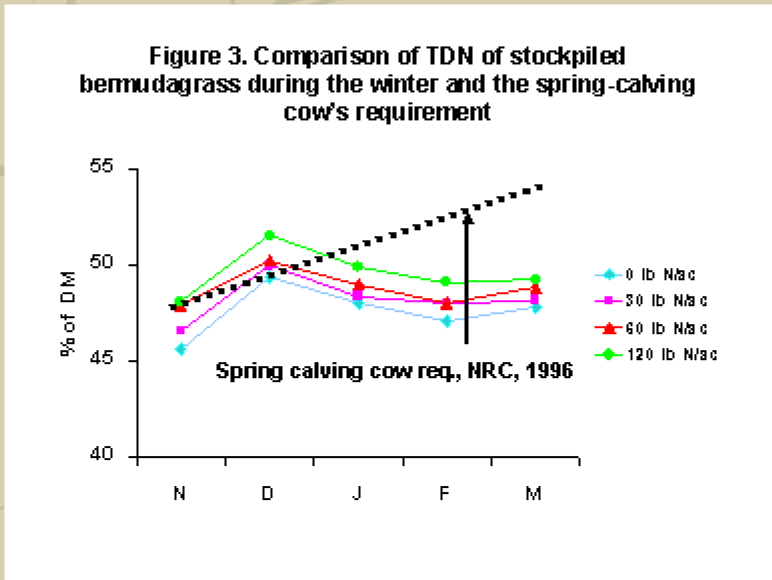
	Harvest Date							
Component	November	December	January	February	March	SE	Fert[a]	Date[a]
Total Digestible Nutrients[F,H]							L	L,Q
0 lbs N/ac	45.7	49.4	48.0	47.1	47.8	.63		
30 lbs N/ac	46.6	50.0	48.4	48.0	48.2	.63		

60 lbs N/ac	48.9	50.3	48.0	48.9	48.1	.63		
120 lbs N/ac	48.1	51.6	49.9	49.1	49.3	.63		
Neutral Detergent Fiber[F,H,X]							L	L,Q
0 lbs N/ac	76.2	76.6	78.0	78.1	77.1	1.46		
30 lbs N/ac	75.3	76.2	77.5	77.5	77.4	1.46		
60 lbs N/ac	74.0	74.0	76.7	77.3	77.0	1.46		
120 lbs N/ac	71.8	72.5	74.5	75.3	75.9	1.46		
Acid Detergent Fiber[F,H,X]							L,Q	L,Q
0 lbs N/ac	42.0	40.7	41.9	42.9	42.0	.39		
30 lbs N/ac	40.9	39.5	40.7	41.6	41.5	.39		
60 lbs N/ac	39.4	38.5	39.8	41.1	40.6	.39		
120 lbs N/ac	37.6	37.0	38.9	39.8	40.1	.39		
Lignin[F,H]							L	--
0 lbs N/ac	8.28	7.81	8.28	8.12	8.05	.22		
30 lbs N/ac	8.05	7.66	8.17	8.06	8.03	.22		
60 lbs N/ac	7.94	7.69	8.08	8.06	7.99	.22		
120 lbs N/ac	7.95	7.34	7.91	7.97	7.91	.22		
Non Structural Carbohydrates[F, H]							L	Q
0 lbs N/ac	7.19	10.96	9.55	7.97	8.62	.99		
30 lbs N/ac	7.47	10.86	9.54	8.53	8.74	.99		
60 lbs N/ac	8.64	11.11	10.12	8.27	9.75	.99		
120 lbs N/ac	7.84	11.34	10.78	9.66	9.50	.99		

[a]Contrasts significant at the P<.05 level: L = linear, Q = quadratic

[FHX]Significance in model at the P<.05 level: F = fertilization rate, H = harvest date, X = fertilization by harvest date interaction

Harvest date also influenced TDN, fiber fractions, and NSC (Table 1). Harvest date had a quadratic effect on TDN, NSC, NDF, and ADF. For TDN and NSC, peak concentrations were observed in December with levels slightly declining through March. Neutral detergent fiber and ADF concentrations tended to increase throughout the winter. Johnson et al. (2001) reported a similar pattern of organic matter digestibility decline when bermudagrass plots were harvested from early summer through early fall. Scarborough et al., (2001) reported that optimal nutritive value of stockpiled bermudagrass in Arkansas occurred from October through December, with nutritive value declining into the winter. Previous research by our group (Wheeler et al., 1999; Johnson et al., 2001) indicates that stockpiled bermudagrass nutritive value is adequate to maintain spring-calving cows through December, however energy supplementation may be required later in the winter. When comparing TDN concentrations from this study to the spring-calving cow's nutritional requirements (Figure 3), stockpiled bermudagrass forage may meet the cow's requirements through December. However, energy supplementation may be required later in the winter.



Increasing rates of N fertilization resulted in linear increases in total crude protein concentration and all degraded protein fractions (Table 2). Averaged across harvest dates, CP concentration increased over the 0 lb N/acre treatment 8, 14, and 30% for the application of 30, 60, and 120 lb N/acre, respectively. Johnson et al. (2001) reported increases over the control plots of 10, 30, and 38% for the monthly application of 35, 70, and 105 lb N/acre. Since the treatments in the current study were only applied once, that may explain the slightly lower increases that were observed. The largest changes (Table 2) were observed for the rapidly degraded soluble protein fraction with increases of 11, 21, and 40% for 30, 60, and 120 lb N/acre as compared with the control (0 lb N/acre).

Harvest date influenced CP and all protein fractions in a quadratic manner (Table 2). Peak CP occurred in November, declined through December and generally stabilized by January. All protein fractions mimicked the trend observed for CP. However, comparing CP concentrations to the spring-calving cow's requirement for protein (Figure 4), it is evident that protein requirements can be met by the 120 lb N/acre treatment throughout the entire winter.

Figure 4. Comparison of CP of stockpiled bermudagrass during the winter and the spring-calving cow's requirement

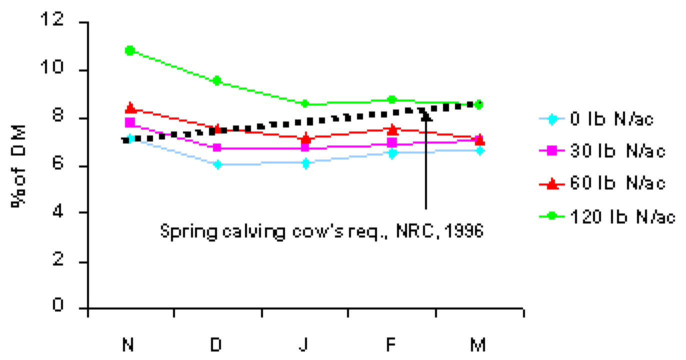


Table 2. Effect of fertilization rate and harvest date on total crude protein and protein fractions of stockpiled bermudagrass (expressed as a percent of forage dry matter)								
	Harvest Date							
Component	November	December	January	February	March	SE	Fert[a]	Date[a]
Crude Protein[F,H,X]							L	L,Q
0 lbs N/ac	7.14	6.06	6.11	6.54	6.63	.50		
30 lbs N/ac	7.77	6.73	6.70	6.91	7.03	.50		
60 lbs N/ac	8.43	7.57	7.18	7.55	7.09	.50		
120 lbs N/ac	10.78	9.49	8.60	8.72	8.55	.50		
Rapidly Degraded Protein[F,H,X]							L	L,Q
0 lbs N/ac	1.39	1.37	1.32	1.43	1.60	.20		
30 lbs N/ac	1.65	1.60	1.52	1.52	1.68	.20		
60 lbs N/ac	2.02	1.92	1.67	1.71	1.64	.20		
120 lbs N/ac	2.93	2.63	2.21	2.06	2.07	.20		
Moderately Degraded Protein[F,H]							L	L,Q
0 lbs N/ac	2.40	1.86	1.99	2.18	2.13	.27		
30 lbs N/ac	2.60	2.02	2.15	2.31	2.21	.27		
60 lbs N/ac	2.69	2.29	2.30	2.52	2.34	.27		
120 lbs N/ac	3.48	2.88	2.75	2.99	2.83	.27		
Slowly Degraded Protein[F,H,X]							L	L,Q
0 lbs N/ac	1.99	1.84	1.68	1.75	1.74	.10		
30 lbs N/ac	2.24	2.11	1.90	1.98	1.97	.10		
60 lbs N/ac	2.51	2.35	2.07	2.08	1.92	.10		
120 lbs N/ac	3.12	3.01	2.45	2.37	2.34	.10		
Non-degraded Protein[H,X]							L	Q
0 lbs N/ac	1.34	.99	1.11	1.18	1.15	.06		
30 lbs N/ac	1.29	0.99	1.13	1.09	1.17	.06		
60 lbs N/ac	1.22	1.01	1.23	1.24	1.19	.06		

120 lbs N/ac	1.24	.97	1.18	1.30	1.30	.06		

[a]Contrasts significant at the P<.05 level: L = linear, Q = quadratic

[FHX]Significance in model at the P<.05 level: F = fertilization rate, H = harvest date, X = fertilization by harvest date interaction

Implications

Increasing rates of nitrogen fertilization increases the forage accumulation of stockpiled bermudagrass and can increase the amount of energy and protein available to the cow. However, advancing harvest date results in a decrease of available energy and protein and an increase in fiber concentrations of stockpiled bermudagrass. Energy supplementation may be required after December in order to minimize weight and loss of body condition in beef cows. Little or no protein supplementation may be required from November through January when at least 60 lb N/acre is applied during late summer. However, minimal crude protein supplementation may be required from January through March to meet nutritional requirements of the spring-calving cow.

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