Effect of Nitrogen Fertilization and Stage of Maturity of Mottgrass (*Pennisetum purpureum*) on its Chemical Composition, Dry Matter Intake, Ruminal Characteristics and Digestibility in Buffalo Bulls

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ABSTRACT : Four ruminally cannulated buffalo bulls were fed mottgrass diets using a 4×4 Latin square design. Treatments were arranged factorially and consisted of mottgrass fertilized with 0 for 46 Kg nitrogen (N) per acre and harvested at 40 and 60 days of age. Nitrogen fertilization improved the concentrations of neutral detergent fiber (NDF), and acid detergent fiber (ADF) in early-cut mottgrass (ECM) but, the acid detergent lignin (ADL) contents were higher in the late-cut mottgrass (LCM). The crude protein (CP) contents of the mottgrass decreased with advancing maturity, but N fertilization increased CP at both maturities. The intake of dry matter (DM), organic matter (OM), CP, NDF and ADF were higher by buffalo bulls fed ECM than those fed LCM. The ruminal pH increased in first 6 hours post feeding in animals fed N fertilized mottgrass and may be due to higher concentration of ruminal ammonia. The digestibilities of DM, OM, CP, NDF and ADF were higher by buffalo bulls fed ECM than those fed LCM. However, the application of N fertilizer did not affect the digestibilities of these nutrients. (*Asian-Aus. J. Anim. Sci. 1999. Vol. 12, No. 7 : 1035-1039*)

Key Words : Mottgrass, Digestibility, Maturity, Buffalo, Fertilizer

INTRODUCTION

Mottgrass, because of its rapid growth and high yield, can be one of the major sources of nutrients for ruminants in Pakistan. This grass does not exhibit summer dormancy and thus, can not only make fodder shortage good in summer but also help regulate the supply of fodder the year round. Regular supply of quality forages in sufficient amount is considered essential for efficient ruminant livestock production. Forage contributes about 75% of the dietary needs of the ruminants fattened on liberal grain supplements, and in areas of the world where grain feeding is not common, ruminants obtain about 95% of their nutrient requirements from forage (Bula et al., 1977). Moreover, a rapidly expanding human population will compete with livestock for edible grains and consequently ruminant animals will be increasingly dependent on forages. This situation indicates that fiber will remain a major fraction in the diet of ruminants.

Increased DM intake results in improved performance and consequently high profitability. Analysis of mottgrass showed a mean concentration of 7.6% DP (Nisa and Sarwar, 1998), a level that may be inadequate for maximal feed intake (Minson, 1982). Dry matter intake in buffalo male calves was improved when fed mottgrass in combination with berseem hay (Nisa and Sarwar, 1998). This increased DM intake by ruminants was due to greater supply of N from berseem. Optimal concentration of ruminal NH_3 is required for microbial protein synthesis and fiber degradation. These bacteria subsequently are digested by the animal and their protein is used to supply amino acids for growth, milk production, fetal development or wool production.

Digestive utilization of forages by ruminants is limited by concentration of forage NDF and degradability of its cell wall material. Digestion of forage is also influenced by species, maturity, agronomic practices and morphology of forages (Cherney et al., 1993; Sarwar et al., 1995). Both the stage of forage maturity and N fertilization are important practices that affect yield and quality of the forages (Sarwar et al., 1994). Reid et al., (1988) reported increased CP and NDF concentrations of N fertilized forage. However, Jung et al. (1990) reported no difference in CP content of N fertilized grass. These inconsistent results of N fertilizer on forage quality suggest that further research needs to be undertaken. The objectives of this research were to determine the influence of N fertilization and stage of maturity on forage composition, feed consumption, ruminal characteristic and digestibility of DM and fiber components.

MATERIALS AND METHODS

The fertilization rate of ECM and LCM was 46 kg N per acre. The fertilizer was applied to each stage of maturity in two separate applications. The date of first application was April 20, 1997 for both maturities and the second application was on May 9, 1997 for ECM and May 19, 1997 for LCM. The ECM and LCM

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hays were harvested manually with sickle after 40 and 60 days after the first cutting from an already established stand of mottgrass and were sun cured.

Animals and diets

Four ruminally cannulated buffalo bulls (300 kg) were used in a 4×4 Latin Square Design with 2×2 factorial arrangement of treatments. The two factors were ECM and LCM hays and two N levels (0 or 46 kg N fertilizer/acre) for each stage of forage maturity.

Feeding and sampling schedule

Animals were housed on a concrete floor in separate pens. Each period of latin Square Design consisted of 15 days. Ten days in each period were given as adaptation time to the new feed followed by 5 days of sample collection. Feed offered and orts were weighed and recorded twice daily. Fecal grab samples were taken twice daily such that a sample was obtained for every three hours interval of 24 hour time period (8 samples). The acid insoluble ash was used as digestibility marker in the study. On day 11, ruminal contents were sampled (500 ml) at 3, 6, 9 and 12 hour after morning feeding, after mixing at each time of these samples, 50 ml were retained from each and the remaining 450 ml were returned to the rumen.

Ruminal pH was measured immediately from the sample retained and then it was squeezed through four layers of cheese cloth. Three millitters of 6 N HCl were added to terminate fermentation and samples were frozen. After thawing, these samples were used to determine ammonia (Chaney and Marbach, 1962). Feed, orts and fecal samples were dried at 55℃ and ground though a Wily mill (2 mm screen). These samples were analyzed for DM, N, and OM using method described by AOAC (1990), NDF, ADF and ADL by the method of Van Soest et al. (1991).

Statistics analysis

Data were analyzed as a 4×4 Latin Square Design with a 2×2 factorial arrangement of treatments using the General Linear Model procedure of SAS (1988). The sum of square of the model were separated into animal, period, treatments and interaction between fertilizer level and maturity stage. In case of an interaction, means were separated by Duncans multiple range test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Forage composition

Advancing maturity appeared to result in lower concentration of CP and higher concentration of fibre components (table 1). The amount of ADL as a percentage of NDF increased with the maturity from 10.48 to 16.31%. Increased lignification of NDF generally occurs when grasses mature from the vegetative to full head stage (Smith et al., 1972).

Fertilization appeared to result in higher concentrations of CP as well as all fibre components of the mottgrass. The N fertilization increased CP of mottgrass at both maturities. The numerical difference between fertilized and unfertilized was greater for ECM (4.1 percentage units) than for LCM (3.7 percentage units). Similar results have been reported for bromegrass (Messman et al., 1991) and orchardgrass (Reid et al., 1988).

Table 1. Chemical composition of forages (DM basis)[a]

	ECM		LCM	
Parameters	-N	+N	-N	+N
OM	95.1	94.7	93.2	90.1
CP	08.6	12.7	07.1	10.8
NDF	70.6	73.6	78.3	79.1
ADF	40.8	43.0	49.4	49.9
ADL	07.4	08.3	10.9	12.9
Cellulose	33.4	34.7	38.5	37.0
Hemicellulose	29.8	30.6	28.9	29.2

[a] Harvested at two maturities (40 and 60 days) and fertilized with 0 (-N) or 46 Kg N/acre (+N), ECM=Early-cut mottgrass and LCM=Late-cut mottgrass.

Feed intake

Intake of DM, OM, CP, NDF and ADF were lower by buffalo bulls when fed the LCM versus the ECM (table 2) and is consistent with christen et al., (1990) who reported decreased intake with advancing forage maturity. Increased forage maturity has been correlated positively with rumen fill and negatively with DM intake (Shaver et al., 1988). Intestinal transit time and gastrointestinal mean retention time increased with advancing plant maturity (Park et al., 1994). Forage quality, as exerted by physiological maturity affects digesta passage rate from the rumen and subsequently forage intake (Emanuele and staples, 1988). the increase in fiber components may have exerted a physical limitation on the gastrointestinal tract that reduced voluntary intake (Baile and Frobes, 1974). Dry matter intake was negatively correlated with NDF and ADL:ADF ration (Adams et al., 1987). This confirms the results of Balch and Camplings (1962) who demonstrated that voluntary intake was inversely related to the fiber contents of the plant.

Nitrogen fertilization has increased the consumption of DM, OM, CP, NDF and ADF. Puoli et al. (1991) reported that application of N fertilizer increased DM intake of pangola digitgrass (Digitaria decumbens) by sheep. Nitrogen fertilized forage stimulated DM intake due to reduced DM and NDF ruminal retention times

(Christen et al., 1990). The LCM at zero-level N had low CP concentration (7.1%; table 1), suggesting that CP concentration of less than 8% limited DM intake.

Ruminal characteristics

The ruminal pH tended to be higher in first 6 hours post-feeding in animals fed N fertilized mottgrass. This may be due to higher concentration of ruminal ammonia in animals fed N fertilized mottgrass (table 3). Our results also supported the findings of other workers (Adams et al., 1987) who reported decreases in ruminal ammonia with advancing plant maturity. Ruminal ammonia concentrations were greater than 5 mg/dL which is considered essential for optimum microbial growth (Satter and Slyter, 1974).

Digestibility

The digestibilities of DM, OM, NDF and ADF were higher by buffalo bulls fed ECM than those fed LCM (table 4). However, the application of N fertilizer did not affect the digestibilities of these nutrients. This higher nutrient digestibility by animals fed ECM may be due to greater amount of nonstructural carbohydrate in the ECM compared to LCM. The ECM has not only supplied greater amount of rapidly degradable carbohydrates but also provided higher ruminal ammonia, resulting into better ruminal fermentation. Other workers (Park et al., 1994; adams et al., 1987) also reported reduced DM and fiber digestibilities and the forage advanced in maturity. Cherney at al. (1993) reported reduction in digestibility as plants matured. They also reported reduced rate of digestion with increasing maturity and sharpest decline in rate was associated with highest concentration of NDF and lignin of forage. The reduced digestibility of LCM in our study may be due to the protective role of structural components, especially lignin against microbial degradation in the rumen. Lignification

Table 2. Nutrient intake by buffalo bulls fed mottgrass[a]

Parameters	ECM		LDM		p-value[b]			SE
	-N	+N	-N	+N	M	F	MF	
Intake, kg/d								
DM	7.5	8.9	6.5	7.8	0.05	0.03	0.56	0.47
OM	7.1	8.4	6.1	7.0	0.05	0.04	0.49	0.41
CP	0.6	1.1	0.5	0.8	0.02	0.03	0.21	0.07
NDF	5.3	6.6	5.1	6.2	0.21	0.07	0.51	0.31
ADF	3.1	3.8	3.2	3.9	0.29	0.10	0.58	0.27
ADL	0.6	0.7	0.7	1.0	0.05	0.05	0.07	0.09
Cellulose	2.5	3.1	2.5	2.9	0.12	0.06	0.41	0.19
Hemicellulose	2.2	2.8	1.9	2.3	0.07	0.08	0.32	0.21

[a] Harvested at two maturities (40 and 60 days) and fertilized with 0 (-N) or 46 Kg N/acre (+N).
[b] Effects were maturity (M), fertilizer (F) and their interaction (MF) ECM=Early-cut mottgrass and LCM=Late-cut mottgrass.

Table 3. Ruminal pH and ammonia in buffalo bulls fed mottgrass[a]

Parameters	ECM		LCM		p-value[b]			SE
	-N	+N	-N	+N	M	F	MF	
				3 hour				
Ruminal pH	6.15	7.22	6.10	7.11	0.21	0.07	0.29	0.31
NH_3-N, mg/dl	17.0	24.0	12.0	18.75	0.05	0.04	0.05	0.98
				6 hour				
Ruminal pH	6.20	7.35	6.9	7.22	0.31	0.03	0.25	0.08
NH_3-N, mg/dl	14.5	20.50	12.0	16.0	0.05	0.05	0.11	0.87
				9 hour				
Ruminal pH	6.78	7.0	6.94	6.95	0.22	0.13	0.35	0.31
NH_3-N, mg/dl	11.25	13.25	10.0	11.25	0.11	0.13	0.41	0.76
				12 hour				
Ruminal pH	6.85	6.87	7.17	7.08	0.19	0.17	0.31	0.29
NH_3-N, mg/dl	9.63	9.75	8.88	9.5	0.21	0.19	0.41	0.43

[a] Harvested at two maturities (40 amd 60 days) and fertilized with 0 (-N) or 46 Kg N/acre (+N).
[b] Effects vere maturity (M), fertilizer (F) and their interaction (MF) ECM=Early-cut mottgrass and LCM=Late-cut mottgrass.

Table 4. Digestibility of feed components by buffalo bulls fed mottgrass[a]

Parameters	ECM		LCM		p-value[b]			SE
	-N	+N	-N	+N	M	F	MF	
Digestion (%)								
DM	54.2	61.5	50.7	48.9	0.02	0.11	0.27	1.45
OM	56.6	64.7	53.8	51.19	0.03	0.13	0.31	1.35
NDF	59.8	58.4	52.9	51.1	0.03	0.17	0.42	1.62
ADF	48.9	51.8	43.9	42.8	0.05	0.16	0.39	1.20
Cellulose	59.0	57.7	44.8	43.9	0.04	0.43	0.52	1.48
Hemicellulose	69.7	70.1	67.9	68.4	0.41	0.51	0.58	2.90

[a] Harvested at two maturities (40 amd 60 days) and fertilized with 0 (-N) or 46 Kg N/acre (+N).
[b] Effects vere maturity (M), fertilizer (F) and their interaction (MF) ECM=Early-cut mottgrass and LCM=Late-cut mottgrass.

resulting from plant maturation depresses digestion of cell walls of hays (Jung, 1989). Some of the phenolic compounds of the lignin have been demonstrated to inhibit fiber degradation by ruminal microflora *in vitro* (Theodorou et al., 1987).

CONCLUSION

Nitrogen fertilization enhanced the concentrations of CP at both maturities, but the CP content of the mottgrass decreased with advancing maturity which might have reduced the DM intake by buffalo bulls when fed LCM. The effect of forage maturity on fiber digestion probably is a reflection of differences in fiber concentration between ECM and LCM. The N fertilizer might have extended the period of maturity. Thus, the adverse effects of maturity on the forage quality can be minimized to some extent by N fertilization.

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