Eastern Gamagrass Forage Quality as Influenced by Harvest Management

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INTRODUCTION

Eastern gamagrass [T*ripsacum dactyloides* (L). L.] is a highly productive native perennial, warm season grass, which is palatable and highly digestible. Eastern gamagrass can be utilized for hay, silage, and intensively managed pasture. Most forage quality and yield information for eastern gamagrass has been generated in the Midwest and South (Brejda et al. 1994 and 1996; Burns et al. 1992; Faix et al. 1980; Horner et. al. 1985; and Wright et al. 1983). It is suspected that although yields maybe lower in the Northeast, the forage quality of warm season grasses may be superior to those grown in warmer regions (Van Soest 1994). Information on forage quality and yield is needed in the Northeast to help to determine the feasibility of using gamagrass in the region. It is of interest to determine the proper growth stage to cut eastern gamagrass and to ascertain its rate of decline during maturity. Information is needed about forage quality variability within eastern gamagrass. Reproductive and vegetative tillers were looked at separately in order to determine if selecting for specific tiller types in a breeding program would influence total herbage forage quality and to compare eastern gamagrass with other warm season grasses studied in a similar fashion (Griffin and Jung 1983; Perry and Baltensperger 1979 and Twidwell et al. 1988). Objectives were to 1) evaluate the forage quality of eastern gamagrass grown in the Northeast, 2) determine the effects of cutting dates and intervals on forage quality, 3) assess forage quality differences between accessions for reproductive and vegetative tillers, and 4) evaluate the difference in forage quality between reproductive and vegetative tillers of eastern gamagrass.

MATERIALS AND METHODS

Two forage quality studies were conducted in 1997 and 1998. A time of cutting study was conducted on an established 6-year-old stand of eastern gamagrass, cultivar 'Pete', on a Unadilla silt loam soil at Big Flats, New York. The stand received 112 kg ha^{-1} yr^{-1} of nitrogen on June 4, 1997 and May 27, 1998. Three replicated plots were harvested (4 individual plants per rep) at three 1st cutting dates, starting on 6/13/97 and 5/28/98 and taken at weekly intervals. A second cutting was sampled at three intervals, four, five and six weeks.

A forage quality study was conducted evaluating the vegetative and reproductive tillers of six agronomically superior accessions and 'Pete'. Four individual plants

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were sampled at the three 1st cutting dates for each accession. Plants were dried at 60°C. Material was ground to pass through a 2-mm screen in a Wiley mill, and were then reground to pass a through a 1-mm screen in a cyclone mill (Udy Corp., Fort Collins, Co) in preparation for quality analyses. Samples (0.5 g) were sequentially analyzed for neutral detergent fiber (NDF), acid detergent fiber (ADF), and sulfuric acid lignin according to procedures described by Van Soest et al. (1991), except that the filter bag technique was used with the ANKOM 200/220 Fiber Analyzer. In vitro true digestibility (IVTD, 0.25 g), and digestible NDF (dNDF) were determined according to Cherney et al. (1997) using the rumen fluid buffer described by (Marten and Barnes 1980) and using the Dairy II 200/220 In Vitro Incubator and the ANKOM 200/220 Fiber Analyzer. The buffer contained urea (0.5g l^{-1}) as supplemental N. Ruminal fluid inoculum was obtained from a non-lactating, rumen-fistulated, Holstein cow fed a medium quality orchardgrass hay diet for ad libitum intake. Nitrogen was determined by a Dumas type N combustion analyzer (Leco, St. Joseph, MI).

RESULTS AND DISCUSSION

TIME OF CUTTING STUDY

The NDF, ADF, and lignin all increased with advancing initial spring harvest date, while IVTD and dNDF declined in first cutting samples, as expected (Table 1). The CP content of eastern gamagrass was not as influenced by harvest date as were other variables, such that no differences were detected in 1998 ($P > 0.05$). This may have been due to a cold wet June in 1998, with average temperatures 2.4°C cooler and 3.8 cm more rain than the 25-yr average. The rate of maturity for the eastern gamagrass was slower in 1998 than in 1997. Although the dates of the initial first cutting varied by two weeks (June 13, 1997 and May 29, 1998), growing degree days (GDD) at that point were similar (363 and 339, respectively, for 1997 and 1998). There were significant differences for most variables measured between first cutting dates so that timing appears to be as important in gamagrass as it is in most perennial forages (Cherney et al. 1993). The date of the initial first cutting will be dependent on an acceptable yield and how it impacts subsequent cuttings (Table 2). The second cutting yield increased significantly as the length of the cutting interval increased 1.9, 2.3, and 2.9 Mg ha^{-1} for the 4, 5, and 6 week cutting interval respectively. The NDF of eastern gamagrass was relatively high in comparison to perennial cool season grasses grown in NY (Cherney et al. 1993), but digestibility of both dry matter and NDF was high. The higher than expected NDF may have been due to a low cutting height of 4 inches. The CP in both years was higher than the average for perennial grasses analyzed at the Northeast Dairy Herd Improvement Laboratory, Ithaca, NY from May 97-April 98. Crude protein in both years was higher than that reported by Brejda et al. (1996) even at their rate of fertilizer N application of 224 kg ha^{-1}. This data suggests that acceptable forage quality can be achieved with proper management.

Table 1. Influence of harvest date on forage quality parameters (g kg^{-1}) of eastern gamagrass, first cutting.

Harvest Date	NDF[1]	ADF	Lignin	IVTD	dNDF	CP
1997						
June 13	693[a]	312[a]	33[a]	798[a]	727[a]	163[a]
June 20	773[b]	381[b]	62[b]	751[b]	668[ab]	164[a]
June 27	770[b]	396[b]	68[b]	752[b]	673[b]	159[b]
1998						
May 29	709[a]	319[a]	23[a]	843[a]	778[a]	135[a]
June 4	721[b]	338[b]	26[a]	815[ab]	744[ab]	131[a]
June 12	746[b]	355[c]	30[b]	794[b]	724[b]	130[a]

[1]NDF=neutral detergent fiber, ADF=acid detergent fiber, IVTD=in vitro true digestibility, dNDF=digestible NDF, CP=crude protein.
[a,b,c] Least squares means in the same column and year with different superscripts differ ($P < 0.05$).

Table 2. Total eastern gamagrass yield[1] (Mg ha^{-1}) 1998.

	1st cut	2nd cut	3rd cut	Total
Hdi[2]				
5/29	2.20[a]	2.06[b]	2.25[a]	6.51[a]
6/4	2.38[ab]	2.70[a]	1.75[a]	6.83[a]
6/12	3.26[b]	2.29[b]	1.58[a]	7.13[a]

[1] To convert Mg ha^{-1} to tons ac^{-1} multiply by 0.446
[2] Initial harvest date
[a,b] Least squares means in the same column with different superscripts differ ($P < 0.05$).

Second-cutting samples were affected by initial harvest date and cutting interval, as well as the interaction between the two (Table 3). There were significant interactions between initial harvest date and cutting interval for NDF, ADF, and lignin. Results varied by year and treatment regime, although the range in NDF between cutting regimes was not large in either year (Table 4). The mean crude protein was clearly reduced for the six week second cutting interval regardless of the first cutting date (Table 4). The CP for second cuttings was lower than for first cuttings. There was no topdressing following first cutting. The interaction between initial harvest date and cutting interval was not significant in 1997 or 1998 for IVTD and dNDF, allowing for discussion of main effects. Initial first cutting date had no effect on regrowth IVTD and dNDF in 1997 (Table 5). In 1998, delaying initial harvest resulted in lower second cutting IVTD and dNDF. Differences between years are likely due to environmental differences. Increasing cutting interval decreased IVTD and dNDF in both 1997 and 1998 (Table 5). Results of this cutting study clearly indicate that the third cutting interval (6 weeks) is too long to insure acceptable quality. A 5-week cutting interval or less depending on forage yield is recommended. Delaying harvest until later in spring may also adversely impact forage quality of the second cutting, though this is dependent on climate.

Variety study

There were significant differences between the genotypes for vegetative tillers for all variables measured except for ADF in 1997 and for NDF and Lignin in 1998 (Table 6). For reproductive tillers only lignin in 1998 was not significantly different. Later harvest date resulted in higher ($P < 0.05$) NDF, ADF, and lignin, as might be expected. In vitro digestibility, dNDF, and crude protein generally declined with advancing harvest date in 1997 and 1998. There appears to be little difference in forage quality between reproductive and vegetative tillers when cut at the appropriate time. There are only minor differences between their means with high forage quality indicator values switching between tiller types between years for some of the variables measured.

CONCLUSIONS

Eastern gamagrass provides good quality forage, provided that adequate harvest management is maintained. Crude protein levels of 1^{st} cuttings in 1997 averaged 16%. Although NDF was high, the fiber digestibility and the total digestibility were very high. Based on data in this study, a 5-week cutting interval is recommended unless there is sufficient yield to warrant an earlier cut.

There were significant differences between accessions for most forage quality variables measured for both tiller types. IVTD and dNDF had the most variability between accessions for both tiller types and CP for reproductive tillers. This was noted by the spread in the mean separations between accessions for these parameters. Only minor differences in forage quality were found between reproductive and vegetative tillers when averaged across accessions.

Table 3. Mean square errors as influenced by initial harvest date, cutting interval, and initial harvest date x cutting interval.

Source	NDF	ADF	Lignin	IVTD	dNDF	CP
1997						
Initial harvest date	45.13	61.63	1.62	132.76	165.76	15.70
	(0.01)[1]	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Cutting Interval	0.38	1.18	0.23	194.02	362.51	28.96
	(0.83)	(0.49)	(0.11)	(0.01)	(0.01)	(0.01)
Hdi[2] x Cutting Interval	27.85	13.74	0.77	19.57	27.21	7.87
	(0.01)	(0.01)	(0.01)	(0.27)	(0.39)	(0.01)
1998						
Initial harvest date	10.42	107.80	6.43	79.74	105.90	83.98
	(0.02)	(0.01)	(0.04)	(0.01)	(0.01)	(0.01)
Cutting Interval	11.39	179.09	4.16	333.63	584.90	173.03
	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)	(0.01)
Hdi[2] x Cutting Interval	14.39	32.49	7.54	6.64	19.34	2.91
	(0.01)	(0.01)	(0.01)	(0.26)	(0.08)	(0.04)

[1] Probability level
[2] Initial harvest date

Table 4. Influence of harvest date on forage quality parameters (g kg^{-1}) of eastern gamagrass, second cutting.

Hdi[1]	CI[2]	NDF	ADF	Lignin	IVTD	dNDF	CP
1997							
6/13	4 wk	705	354	43	777	684	128
1	5 wk	708	366	46	717	601	109
1	6 wk	733	379	51	698	589	106
6/20	4 wk	711	364	49	728	617	121
2	5 wk	726	367	48	705	594	127
2	6 wk	719	371	49	698	582	100
6/27	4 wk	711	355	47	770	677	134
3	5 wk	699	341	44	744	634	124
3	6 wk	681	335	43	739	618	123
1998							
5/29	4 wk	743	354	41	815	751	159
1	5 wk	723	357	32	793	713	126
1	6 wk	722	364	29	747	647	108
6/4	4 wk	715	345	31	818	745	129
2	5 wk	713	359	29	782	694	113
2	6 wk	735	409	40	742	649	82
6/12	4 wk	726	361	32	778	694	119
3	5 wk	728	395	39	761	679	101
3	6 wk	738	422	52	729	634	80

[1]Hdi =initial harvest date, [2]CI =cutting interval,

Table 5. Influence of initial first cutting and cutting interval on forage quality parameters (g kg^{-1}) of eastern gamagrass second cutting

	IVTD[1]	**dNDF**
Harvest Date		
1997		
June 13	729[a]	622[a]
June 20	711[a]	598[a]
June 27	751[a]	643[a]
1998		
May 29	786[a]	707[a]
June 4	782[a]	697[a]
June 12	756[b]	668[b]
Cutting Interval		
1997		
4-wk	757[a]	658[a]
5-wk	721[b]	609[b]
6-wk	711[b]	596[b]
1998		
4-wk	804[a]	729[a]
5-wk	778[b]	696[b]
6-wk	739[c]	643[c]

[1]IVTD=in vitro true digestibility; dNDF=digestible neutral detergent fiber.
[a,b,c] Least squares means in the same column, year and main effect with different superscripts differ ($P < 0.05$).

Table 6. Neutral Detergent fiber (NDF; g kg^{-1}), crude protein (CP; g kg^{-1}) and in vitro true digestibility (IVTD; g kg^{-1}) of vegetative and reproductive tillers of eastern gamagrass as influenced by accession.

	NDF		**CP**		**IVTD**	
Accession	Vegetative	Reproductive	Vegetative	Reproductive	Vegetative	Reproductive
1997						
215	714^{ab}	676^{b}	131^{b}	121^{b}	84.1^{ab}	86.0^{a}
316	688^{bc}	692^{a}	129^{b}	109^{cd}	81.2^{d}	81.1^{c}
519	713^{ab}	676^{bc}	123^{b}	102^{d}	83.4^{bc}	83.6^{b}
521	699^{abc}	662^{cd}	129^{b}	105^{cd}	81.3^{d}	81.8^{c}
538	673^{c}	660^{d}	133^{ab}	121^{b}	82.1^{cd}	81.5^{c}
716	720^{a}	663^{bcd}	127^{b}	113^{cb}	85.3^{a}	85.6^{a}
'PETE'	695^{abc}	653^{d}	147^{a}	132^{a}	82.2^{cd}	84.0^{b}
1998						
215	673^{ab}	685^{bcd}	156^{a}	168^{ab}	82.8^{b}	82.8^{b}
316	673^{ab}	700^{ab}	142^{bc}	152^{cd}	79.9^{d}	77.6^{e}
519	670^{ab}	690^{bcd}	136^{bc}	146^{d}	82.5^{b}	82.4^{cb}
521	664^{abc}	691^{bc}	137^{bc}	161^{bc}	80.6^{cd}	80.5^{cd}
538	674^{d}	664^{abc}	135^{bc}	152^{d}	81.7^{cb}	83.1^{b}
716	658^{bc}	682^{cd}	146^{ab}	171^{a}	86.2^{a}	87.1^{a}
'PETE'	670^{ab}	709^{a}	132^{c}	132^{e}	81.5^{bcd}	79.8^{d}

[a, b, c, d]Least squares means in the same column and year with different superscripts differ ($P < 0.05$).

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