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DEFOLIATION MANAGEMENT EFFECTS ON TROPICAL GRASS-LEGUME YIELD, QUALITY AND PERSISTENCE. I. LOW RAINFALL SITE.

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ABSTRACT

The effect of mob-grazing interval (35, 70, 105 and 140 d) on forage dry matter yield, crude protein concentration, in vitro organic matter disappearance (IVOMD) and persistence of grass-legume mixtures was studied on a private ranch located on a leeward site (<900 mm annual rainfall) on St. Croix. Seasonal forage dry matter (DM) yield (7.6 Mg ha^{-1}) was not affected (P>0.05) by grazing interval because of drought towards the end of the season. Crude protein (CP) concentration in both legume (145-240) and grass (50-124) declined quadratically with increasing grazing interval. Although IVOMD of forage also generally declined (P<0.05) with increasing grazing interval, differences in varietal response were observed. The decline in IVOMD with forage maturity for desmanthus (*Desmanthus virgatus)* and glycine (*Neonotonia wightii*) occurred in a quadratic manner whereas the decline for leucaena (*Leucaena leucocephala)* and teramnus (*Teramnus labialis)* was linear. 'Bisset' creeping bluegrass (*Bothriochloa pertusa)* retained a higher IVOMD with increasing grazing interval than the guinea grass (*Panicum maximum)*. 'Bambatsi' panicum (*Panicum coloratum* var. Makarikariense) and leucaena were more persistent at the 70-105 grazing interval than the other forages at this dry site.

INTRODUCTION

The livestock industry in the Caribbean Basin is largely supported by poorly managed guinea grass pastures which, during recurrent dry season, provide forage that is deficient in both quantity and quality, resulting in reduced animal performance. There is a need to develop cost-effective supplemental forage feeding systems. This report is part of a larger study covering three contrasting sites on St. Croix separated along a rainfall gradient. On St. Croix in the US Virgin Islands, the southeast and southwest coastal areas (leeward) are driest sections experiencing less than 900 mm annual rainfall. The northwest (windward) is the wettest area receiving more than 1250 mm rainfall. Rainfall also varies during the course of the year. The wettest months are September to December and the driest months are January to April. A minor peak in rainfall may occur in May although this has been absent the last few years.

Appropriate forage grass-legume germplasm along with grazing defoliation management systems needed for sustained productive use must be developed for specific rainfall sites. The objective of this study was to evaluate the effect of mob-grazing frequency on performance of several tropical grass-legume mixtures in the Virgin Islands.

MATERIALS AND METHODS

This portion of the study was conducted on Castle Nugent farm, a Senepol cattle breeding operation, located on 830 ha. of brush on the dry east end of St. Croix. Annual rainfall was less than 900 mm and the soil was a mildly alkaline (pH>7.8) Fredensborg clay (fine carbonatic, isothermic, Typic Rendoll Mollisols). The experiment was a split-plot, randomized complete block design with two replicates. Main plots consisted of four grazing intervals (35, 70, 105 and 140 d) and subplots consisted of 10 forage types. The forage types were 1) pure guinea grass control, 2) guinea grass + desmanthus var. CPI 92802, 3) guinea grass + glycine var. CPI 52614, 4)

Bambatsi + desmanthus, 5) Bambatsi + glycine, 6) Bisset + desmanthus, 7) Bisset + glycine, 8) leucaena + teramnus, 9) pure desmanthus, and 10) pure glycine. Forages were established from seed during the raining season of November, 1996. Seed was broadcast with a manual cyclone seeder onto a prepared seed bed and lightly raked into the soil.

Guinea grass was seeded at 10 kg ha^{-1}, and all remaining forages at 5 kg ha^{-1}. Seed for grass-legume systems were hand mixed, together with the appropriate legume inoculant, just prior to broadcast. Annual fertilization rates for the pure guinea grass and grass-legume mixtures were 100-30-60 N-P-K and 0-30-60 N-P-K kg ha^{-1}, respeetively. The N for the pure guinea grass was split in two applications (December 1996 and July 1997).

Each forage type plot was 4.6 x 4.6 m with a 0.6 m-wide perimeter border kept free of vegetation during establishment by regular close mowing and rototilling. Each of the two main plot replicates consisted of four 0.03 ha paddoeks eaeh eontaining established plots of all 10 forage types. Grazing interval treatments were randomly assigned to paddoeks in duplicates. Paddocks were rotationally grazed at the prescribed interval to approximately 15-cm stubble from late July 1997 to May 1997. At each grazing, 30 steers /acre^{-1} were allowed to consume forage within a 1- to 2-d period (mob-grazing). The animals were then removed and grass was allowed to regrow.

Pregrazed forage for each forage type within a paddock was sampled from a 0.61 x 1.52 m strip to a stubble of 15 cm for the *Panicum, Desmanthus* and *Leucaena* spp. and 10 cm for the other forage species. Sub-samples of harvested forage were weighed and separated into grass and legume components before drying at 60 °C to constant weight for percentage DM determination. Postgrazed forage was mowed to a 15-cm stubble after each grazing episode to remove residue and reduee contamination of the next pregrazed forage harvest.

Dried pregrazed sub-samples were ground and analyzed for CP (Gallaher et al. 1975, Hambleton 1977) and IVOMD (Moore and Mott 1972). Combined (grass + legume) yield data and component grass and legume CP and IVOMD data were subjected to statistical analyses of variance (SAS Institute Inc. 1987). For significant treatment effeets, forage type means were separated by Duncan's Multiple range test and grazing interval by the least significant difference method.

RESULTS AND DISCUSSION

Herbage mass of the initial 8-month establishment growth ranged from 3.7 to 7.9 Mg ha^{-1} depending on forage type ($P<0.0001$). The initial yield was greatest for forage types based on *Panicum* species (guinea/grass and Bambatsi) and lowest for pure legumes (Table 1). After the imposition of grazing in July 1996, pregrazed forage yield of the aftermath was also greatest from *Panicum*-based forage systems (Table 1). Panicums are naturalized in most Caribbean Islands and exhibit prolific regrowth at the onset of the growing season, especially under a rotational grazing management system. The gross seasonal pregrazed DM yield ranged from 9 Mg ha^{-1} for the pure legumes to 17 Mg ha^{-1} for guinea grass-desmanthus mixture (Table 1).

The initial herbage mass prior to the imposition of grazing was similar across paddoeks (4.2 to 5.5 Mg ha^{-1}, Table 2). This was indicative of uniformity of forage establishment. After the initiation of grazing, aftermath pregrazed forage yields were also independent of grazing interval (Table 2). The lack of aftermath forage yield response to grazing interval was mainly due to the occurrenee of drought spells towards the end of the season which had a more negative impact on the 105 and 140 d treatments.

Glycine and desmanthus were similar in CP concentration (170 g kg^{-1}). Crude protein concentration in pregrazed legume component declined linearly from 240 to 145 g kg^{-1} with increasing grazing interval (Table 3). Mean CP concentration in pre-grazed grass forage was not affected ($P>0.05$) by forage type despite a trend towards a lower CP coneentration in guinea grass-based systems (Table 4). Generally, grass CP concentrations depend on the level of N fertilization. Pure guinea grass plots received 100 kg N ha^{-1}, annually, but exhibited no overall improvement in CP concentration over grass forage from grass-legume mixtures. As expected, pregrazed grass

CP concentration declined uniformly in a quadratic manner from 124 to 50 g kg^{-1} with increasing grazing interval (Table 4).

Table 1. The effect of forage type on initial, aftermath and seasonal total pregrazed forage dry matter yields at Castle Nugent Farm.

Forage Type	Initial Mg ha^{-1}	Aftermath Mg ha^{-1}	Total Mg ha^{-1}
Guinea grass	7.9 a*	8.6abc	16.5a
Guinea grass + Desmanthus	6.1 ab	10.7a	16.8a
Guinea grass + Glycine	6.2 ab	7.0bcd	13.2abc
Bambatsi + Desmanthus	6.3 ab	9.6ab	15.9ab
Bambatsi + Glycine	6.1 ab	8.9abc	15.0ab
Bisset + Desmanthus	4.4 bc	7.5bcd	11.9bc
Bisset + Glycine	4.4 bc	7.5bcd	11.9bc
Leucaena + Teramnus	3.5 c	6.8bcd	10.3c
Desmanthus	3.6 c	5.2d	8.8c
Glycine	3.7 c	6.2dc	9.9c

*Values in a column followed by the same letter are not significant at P = 0.05.

Table 2. The interactive effect of harvest date and grazing interval on pregrazed forage dry matter yield at Castle Nugent Farm.

Grazing interval (d) 1-23-97 (Mg ha^{-1})	Initial (7-31-96) 2-27 (Mg ha^{-1})	Aftermath 9-4-96 3-24 (Mg ha^{-1})	Harvest dates 10-10 4 -28 (Mg ha^{-1})	Aftermath 11-19 total (Mg ha^{-1})	Gross 12-18 total (Mg ha^{-1})
35	5.50	0.23	2.37	0.71	1.89
1.71	0.76	——	——	7.7	13.2
70	5.86	——	2.67	——	2.80
——	2.97	——	——	8.4	14.3
105	5.06	——	——	2.92	——
——	——	3.36	——	6.3	11.3
140	4.26	——	——	——	5.71
——	——	——	2.22	7.9	12.2
LSD (0.05)	NS	NS	NS		

The combination of leucaena + teramnus had the highest legume CP concentration of 234 g kg^{-1} (Table 3).

The IVOMD of desmanthus was lower than the IVOMD for the other tropical legumes, especially at the early stage of growth (35 d) (Table 5).. From previous studies (Adjei et al. 1993), young desmanthus forage is known to be high in tannin content which becomes diluted with DM as plant matures. The response of pregrazed legume IVOMD to grazing interval was variable among the species. Pregrazed legume IVOMD declined in a linear manner for leucaena + teramnus forage but in a quadratic manner for glycine and desmanthus forage (Table 5). The IVOMD of pregrazed grass forage was similar for the forage types at the early stage of growth (35 d) but differences among grasses became pronounced with increasing grazing interval. Differences in grass IVOMD response to advancing maturity is reflective of variable lignification rates among the grasses. Bisset creeping bluegrass, was the least fibrous among the grasses and retained the highest pregrazed forage IVOMD with increasing grazing interval (Table 6).

Table 3. The effect of forage type and grazing interval on pregrazed legume crude protein concentration at Castle Nugent Farm.

Forage Type	Grazing interval (d) 35	70	105	140	Mean
	g kg⁻¹	g kg⁻¹	g kg⁻¹	g kg⁻¹	g kg⁻¹
Guinea grass	—	—	—	—	—
Guinea grass + Desmanthus	—	—	—	—	—
Guinea grass + Glycine	—	—	155	146	151 c*
Bambatsi + Desmanthus	280	181	142	129	183 b
Bambatsi + Glycine	193	183	165	160	175 b
Bisset + Desmanthus	239	193	150	136	179 b
Bisset + Glycine	—	179	159	137	158 bc
Leucaena + Teramnus	307	257	185	186	234 a
Desmanthus	215	175	158	139	172 b
Glycine	200	175	157	126	165 b
Mean	239	192	159	145	

LSD (0.05) for Grazing Interval Means: 16

* Means of forage type followed by the same letter are not different at P = 0.05.

Table 4. The effect of forage type and grazing interval on pregrazed grass crude protein concentration at Castle Nugent Farm.

Forage Type	Grazing interval (d) 35	70	105	140	Mean
	g kg⁻¹	g kg⁻¹	g kg⁻¹	g kg⁻¹	g kg⁻¹
Guinea grass	110	82	55	49	76 a*
Guinea grass + Desmanthus	120	80	51	39	74 a
Guinea grass + Glycine	125	88	43	27	71 a
Bambatsi + Desmanthus	136	99	88	38	90 a
Bambatsi + Glycine	128	110	63	45	87 a
Bisset + Desmanthus	122	100	83	75	95 a
Bisset + Glycine	113	116	67	74	93 a
Leucaena + Teramnus	—	—	—	—	—
Desmanthus	—	—	—	—	—
Glycine	—	—	—	—	—
Mean	124	96	64	50	

LSD (0.05) for Grazing Interval Means: 31

* Means of forage type followed by the same letter are not different at P = 0.05.

Table 5. The interactive effect of forage type and grazing interval on in vitro organic matter disappearance of pregrazed legume component at Castle Nugent Farm.

Forage Type	Grazing interval (d) 35	70	105	140	Mean
	g kg⁻¹	g kg⁻¹	g kg⁻¹	g kg⁻¹	g kg⁻¹
Guinea grass	—	—	—	—	—
Guinea grass + Desmanthus	—	—	—	—	—
Guinea grass + Glycine	—	—	638 c*	631 a	635
Bambatsi + Desmanthus	477 b	580 b	516 c	431 c	501
Bambatsi + Glycine	—	712 ab	670 bc	620 a	667
Bisset + Desmanthus	—	750 ab	610 c	436 c	599
Bisset + Glycine	—	908 a	814 ab	599 a	774
Leucaena + Teramnus	698 a	687 ab	622 c	508 b	629
Desmanthus	444 b	759 ab	578 c	430 c	552
Glycine	586 ab	891 a	841 a	603 a	730
Mean	551	755	661	532	

* Means of forage type within each grazing interval followed by the same latter are not different at P=0.05. Forage type x grazing interval interaction P<0.05.

Table 6. The interactive effect of forage type and grazing interval on in vitro organic matter disappearance of pregrazed grass component at Castle Nugent Farm.

Forage Type	Grazing interval (d)				
	35 g kg^{-1}	70 g kg^{-1}	105 g kg^{-1}	140 g kg^{-1}	Mean g kg^{-1}
Guinea grass	600 a*	654 b	630 b	484 b	585
Guinea grass + Desmanthus	661 a	662 b	548 b	552 ab	606
Guinea grass + Glycine	614 a	685 b	591 b	531 ab	605
Bambatsi + Desmanthus	628 a	656 b	577 b	540 ab	600
Bambatsi + Glycine	601 a	673 b	664 ab	494 b	608
Bisset + Desmanthus	634 a	831 a	737 a	566 a	692
Bisset + Glycine	635 a	855 a	741 a	586 a	709
Leucaena + Teramnus	—	—	—	—	—
Desmanthus	—	—	—	—	—
Glycine	—	—	—	—	—
Mean	627	717	637	536	

* Means of forage type within each grazing interval followed by the same latter are not different at P=0.05. Forage type x grazing interval interaction P<0.05.

Visual assessment of forage stands after a year of rotational grazing (data not included) suggested a greater persistence of Bambatsi and leucaena entries.

CONCLUSIONS

At a dry leeward site in the Caribbean Basin, seasonal pregrazed forage DM production, without N application, was more than 15 Mg ha^{-1} for *Panicum*-legume mixtures under a rotational grazing management system. When grazed at 70 to 105 d intervals, the range in CP concentration in legume and grass components were 159-192 and 64-96 g kg^{-1}, respectively. Corresponding ranges in IVOMD were 661-755 for the legume and 637-717 for the grass components. Potential exists for selecting appropriate tropical grass-legume mixtures for specific sites to boost livestock production in the region. Bambatsi could become an alternative to guinea grass pasture since it seems to be more persistent on a dry site.

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