Plant biomass and bovine live weight changes in mono-specific and mixed pastures during the rainy season in dry tropical Mexico

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Abstract. Dry tropics suffer long drought periods each year, negatively affecting the amount and digestibility of forage for cattle production. The aim of this study was evaluate different pasture types, grazed by cattle during the rainy season. Three hectares were prepared to compare: grass monoculture, *Andropogon gayanus* (G); a grass-legume mixture of *A. gayanus* and *Clitoria ternatea* (GL), and a grass-legume-tree mixture of *A. gayanus*, *C. ternatea* and *Morus alba* (GLT). Two grazing cycles (4 d grazing followed by 32 d resting; 72 d total) were completed. Three heifers (average initial weight 192 kg) grazed each experimental unit. The amounts of forage offered, remaining after grazing, and removed by animals differed significantly among the pasture treatments. Total forage offered by period was 2007, 4089**,** and 4192 DM kg/ha for G, GL, and GLT, respectively. Total residual forage was 1074, 1878 and 2613 DM kg/ha respectively, while total forage removed was 934, 2209, and 1579 DM kg/ha, respectively. Differences for offered forage were detected only for residual and consumed forage for GL prairies. Differences in available forage were mainly due to differences in the amount of stem and live material. Daily weight gain was 0.138, 0.504 and 0.501 kg per animal for G, GL, and GLT, respectively. Mixed pasture treatments yielded better live weight gain due to the better quality of available forage.

Keywords: Mixed pasture, morphological components, grazing cattle, rainy season.

Introduction

Biodiversity loss is related to the degradation of rangelands and pastures. The National Climate Change Strategy in Mexico (SEMARNAT, 2007) identified the conversion of farming systems to silvo-pastoral and agro-pastoral systems as an area of research that requires special attention. In pasture-based cattle farming systems in the tropics, the main constraints to improved herd productivity are poor forage quality and the limited period for which pasture can grow due to the seasonal rainfall pattern. The objective of this study was to describe the forage biomass and weight gain of bovines grazing three pastures in a dry tropical environment during the rainy season.

Methods

The study was carried out in the Iguala Experimental Station of the National Forestry, Crops and Livestock Research Institute (INIFAP), at 99° 33' W and 18° 22' N and altitude of 635 m. The climate is dry tropics with summer rains. The experimental area comprised 3.0 hectares divided into three 1.0 ha blocks to which three pasture treatments were randomly allocated: *Andropogon gayanus* alone (grass alone, denoted 'G'), *A. gayanus* and *Clitoria ternatea* (grass plus legume, denoted 'GL'), or *A. gayanus*, *C. ternatea* and *Morus alba* (grass plus legume plus tree, denoted 'GLT'). Forage species were established 16 months before the experimental phase started. Grazing was rotational, consisting of 4 and 32 days of occupation and rest, respectively. Two grazing cycles were completed during the drought season (November to March). The dynamics of biomass were assessed using a transect, along which forage on-offer was measured on one side and residual forage on the other side for each grazing period, using a 32 day interval. For both variables, all herbage within a $4m^2$ quadrat was cut to estimate non senescent forage material. A subsample (1.0 kg of fresh forage) was collected and dissected into leaves, stems, inflorescences and dead material. Dry matter content was determined by weighing after drying at 55 °C for 72 h. Pastures were grazed with weaned cattle (Brown Swiss crossed with Zebu) with an average initial weight of 192 kg. An adaptation period of 15 to 21 days was allowed prior to commencement of the first grazing cycle. Animals were weighed at the beginning and end of each grazing cycle, at the same time of day, without being fasted. The data were analyzed using the SAS program GML procedure (2002).

Results and discussion

Biomass offered was higher (P<0.05) in the two mixed pastures compared to the monospecific pasture (Table 1). Residual biomass was greater in GLT than in G, with the GL treatment intermediate. Consumed forage was greater (P<0.05) for GL prairies, compared to G and GLT, which were similar (P>0.05)

Differences in biomass were due mainly to differences

Table 1. Differences for pasture biomass among three tropical pasture treatments during two grazing periods within the rainy season in tropical México.

Pasture	Pasture biomass (kg DM/ha)		
	Offered	Residual	Disappeared
A. gayanus	2006.5 b	1073.3 b	933.3 b
A. gayanus and *C. ternatea*	4089.2 a	1887.7 ab	2211.5 a
A. gayanus, *C. ternatea* and *M. alba*	4191.8 a	2613.5 a	1578.3 b
Coefficient of variation	14.6	25.3	23.2

[a,b] Means within columns with a letter in common are not significantly different (α<0.05; Tukey)

Table 2. Composition of biomass in three types of tropical pastures during two grazing periods within the rainy season in tropical México.

Pasture	Biomass components (kg DM/ha)		
	Offered	Residual	Disappeared
		Leaf	
A. gayanus	707.8	204.3	503.5
A. gayanus and *C. ternatea*	992.3	269.3	723.0
A. gayanus, *C. ternatea* and *M. alba*	1087.7	373.2	714.5
Coefficient of variation	45.3	65.4	55.8
		Stem	
A. gayanus	605.8 b	370.7 b	235.3
A. gayanus and *C. ternatea*	1693.5 a	914.5 ab	779.0
A. gayanus, *C. ternatea* and *M. alba*	2075.0 a	1530.3 a	544.7
Coefficient of variation	19.4	49.9	63.5
		Live material	
A. gayanus	1313.3 b	575.0 b	738.3 b
A. gayanus and *C. ternatea*	2822.7 a	1227.7 ab	1595.0 a
A. gayanus, *C. ternatea* and *M. alba*	3195.0 a	1903.5 a	1291.5 b
Coefficient of variation	27.1	46.8	25.7
		Dead material	
A. gayanus	449.3	400.5	48.8
A. gayanus and *C. ternatea*	559.8	281.3	278.5
A. gayanus, *C. ternatea* and *M. alba*	654.5	476.3	178.2
Coefficient of variation	51.6	41.0	152.4

[a,b] Means within columns with a letter in common are not significantly different (α<0.05; Tukey)

in the amounts of stem and green material (Table 2). The amount of stem and live material offered was greater in GL and GLT than G. In the residual biomass, the amount of stem and live material was greater in GLT than G, with GL intermediate. There were no significant differences between treatments in the amounts of different forage fractions present in offered or residual pasture.

Removed forage is an indicator of forage harvested by grazing. This fraction was dominated by non-senescent material (Table 2) indicating selection by animals of live herbage compared to dead material. More green forage was removed in the GL treatment than the G treatment, whereas that GLT had an intermediary value.

Mixed pastures produced more biomass with a higher content of live material compared to the grass monoculture treatment, and therefore they yielded the best animal response (expressed as live weight change, Table 3). The mixed pastures were similar to each other but produced 300% greater live weight gain per animal and per hectare than the monospecific pasture at the same stocking density (P <0.05). In addition to the greater biomass in the GL and GLT treatments, the legume (*Clitoria*) and tree (*Morus*) components should have offered higher quality forage which would have contributed to the much higher weight gain in calves: 0.501 to 0.504 kg per animal per day in GLT and GL respectively, compared to 0.138 kg/day in G. These live weight gains are lower than those reported by Torres *et al*. (2007) for *A. gayanus* in the rainy season of 0.613 and 0.652 kg. Torres *et al*. (2007) used stocking rates of 1.0 and 1.3 AU / ha which were lower than those used in this study (6 calves / ha), which would explain much of the difference in reported weight gain per animal. In other studies of tropical pastures, legumes and legume-grass mixtures have produced forage with high crude protein and low fiber concentrations compared with monospecific grassland pastures (*e.g*. Tessema and Baars, 2006). Moreover, it has been reported that *M. alba* leaves contain 14.3% crude protein and 24.6% ADF with a DM digestibility of 82.1% (Shayo 1997) which should yield good energy and nutrient supply for grazing ruminants.

Conclusion

Pastures containing grass, legume and tree had the highest forage yield of all three treatments, but the amount of biomass removed by cattle was greatest for the mixture of *Andropogon gayanus* and *Clitoria ternatea*. During the rainy season, differences in the biomass offered and remaining after grazing among the three types of pastures

Table 3. Live weight changes in bovines grazing three types of tropical pastures in the rainy season in tropical México.

Pasture	Live weight change (kg)			
	Per animal		Per hectare	
	Per day	Total period (72 days)	Per day	Total period (72 days)
A. gayanus	0.138 b	9.9 b	0.826 b	59.5 b
A. gayanus and *C. ternatea*	0.504 a	36.3 a	3.028 a	218.0 a
A. gayanus, *C. ternatea* and *M. alba*	0.501 a	36.1 a	3.007 a	216.5 a
Coefficient of variation	51.7	51.7	51.7	51.7

[a,b] Means within columns with a letter in common are not significantly different (α<0.05; Tukey)

were explained by the amounts of stem and live material present. The greater amounts of biomass and live material in the pastures with *Clitoria* and *Morus*, compared to the grass monoculture, promoted greater weight gain in cattle.

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