Article

Productive behavior and quality of hybrid pastures of *Urochloa* and star grass grazing with cattle

Nicolás Torres Salado[1]
Miguel Moctezuma Villar[1]
Adelaido Rafael Rojas García[1]
María de los Ángeles Maldonado Peralta[1§]
Armando Gómez Vázquez[2]
Paulino Sánchez Santillán[1]

[1]Faculty of Veterinary Medicine and Animal Husbandry no. 2-Autonomous University of Guerrero. Cuajinicuilapa, Guerrero, Mexico. (nivigas@yahoo.com.mx; rogarcia-05@hotmail.com; sanchezsantillanp@gmail.com; crysis071@gmail.com). [2]Academic Division of Agricultural Sciences-Autonomous Juárez University of Tabasco. Villahermosa-Teapa highway km 25, Ra. La Huasteca, 2nd section, Center, Tabasco, Mexico. CP. 86298. (armandoujat@outlook.com).

[§]Corresponding author: mmaldonado@uagro.mx.

Abstract

In tropical areas grasses are the main source of food for ruminants, however, environmental conditions and the management of grasslands directly affect their performance and quality. The objective was to study the effect of the performance of the hybrid pastures of *Urochloa* and star grass (*Cynodon plectostachyus*) at different frequencies and grazing intensities, with cattle in the dry tropics. Cobra, Mulato II and Cayman (*Urochloa*) and star grass grasses were evaluated at cut frequencies of 28 and 35 d, and severe and light intensities of 10 and 15 cm, respectively, which were randomly distributed in a block design randomly with 2 x 2 factorial arrangement with three repetitions. Management effect was observed in the accumulation of DM, the accumulation being higher at a lower frequency and light grazing intensity regardless of the grass evaluated. Cobra, Cayman and Mulato II grass obtained the highest frequency yield at 35 light intensity with an average of 6 679 kg DM ha^{-1} while, in that handling the star grass obtained the lowest yield with 4 028 kg DM ha^{-1}. The highest crude protein in leaf, in all pastures was found in severe grazing and intensity at 28 d with 20, 20, 18 and 10% in Cobra, Mulato II, Cayman and star grass, respectively ($p< 0.05$). It is concluded that the highest forage production was obtained by harvesting at a light intensity of 15 cm, every 35 d and the highest protein content was reached when the forage was harvested at an intensity of 10 cm and a frequency of 28 d.

Keywords: frequencies and intensities grazing, quality, tropical grasses.

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Introduction

Modern livestock requires profitability and competitiveness, which is achieved with accelerated increases in food production that guarantee the demand of the population, in a sustainable way without affecting natural resources, decreasing the acquisition of chemical products that reduce environmental pollution, where feeding is the most important factor and forages are the main basis for this (Rojas *et al*., 2005).

In the tropics, grasses are the main source of food for ruminants; however, the environmental conditions and the management of the grassland directly affect their yield and quality, so that the nutritional value and dry matter production is variable (Hernández *et al*., 2002).

The search for forage alternatives, which optimally improve grazing systems, in animal production and increase profitability (Rojas *et al*., 2005), have forced the search for new genetically improved species, which adapt to acidic soils, with low fertility and that favor extensive ranching in Tropical America (Sotelo *et al*., 2003). One of the best known and most widely used forage species are those of the *Urochloa* genus, formerly *Brachiaria* (Garay-Martínez *et al*., 2018), the first commercial apomictic hybrid of this genus was the *Brachiaria* hybrid cv. Mulato (CIAT, 2000; Faría, 2006).

A syntax would be saved in the text if information on this hybrid is added and continue with the rest. Studies carried out as the Cobra Grass (*Brachiaria* hybrid BR02/1794) indicated that grazing should be done at 35 d, at which time the crude protein 14.35% at 56 d presented 2 550 kg DM ha^{-1}, as the development of the plant increases, the quality decreases (Rojas-García *et al*., 2018).

Other researchers (Garay-Martínez *et al*., 2018) when evaluating cv. Insurgente, Cayman, Cobra and Mulato II in the rainy season, at 56 d, of regrowth, had a yield of 9 000 to 10 000 kg DM ha^{-1}, while in the dry season, without irrigation, up to 1 300 kg DM ha^{-1} the cv. Cobra was the most productive, compared to Buffel H-17 (*Pennistum ciliare*), which obtained 8 500 kg in the rain and 900 kg DM ha^{-1} in the dry.

The growth rate of plant species depends on environmental and edaphoclimatic conditions and to take advantage of their yield and quality it is necessary to know the seasonal distribution (McKenzie *et al*., 1999). Mexico presents regions with climatic variability, dry season and rain, in the latter the plant development is abundant, supporting cut or defoliation (Castro *et al*., 2012). Maass *et al*. (2015).

They indicate that, when introducing a forage species to a production system, its behavior must be evaluated, which allows, to know the seasonality, availability and to look for strategies of use in animal production (Avellaneda *et al*., 2008; Garay-Martínez *et al*., 2018). Therefore, the objective of the present study was to evaluate the productive behavior of tropical pastures, in terms of quality and forage production, grazing with beef cattle.

Materials and methods

The study was conducted from June to December 2018, in the rainy season, in the experimental plots of the Faculty of Veterinary Medicine and Zootechnics No. 2 of the Autonomous University of Guerrero, located in Cuajinicuilapa, Guerrero, Mexico (16° 28' 28'' north latitude and 98° 25' 11.27'' west longitude at 46 m altitude). The climate is classified Aw and called the dry tropics (García, 2004).

The soil was analyzed in 2016 and was identified as sandy loam soil, with a pH of 8.1 and little organic matter with 1.5%. The average annual temperature in the study period was 27.5 °C and accumulated precipitation of 1 195 mm (Table 1). Climatic data were obtained from the CONAGUA agro-meteorological station located 1 000 m from the experimental plots.

Table 1. Distribution of precipitation and average, maximum and minimum monthly temperature that were recorded during the experimental period.

Month	Maximum	Minimum	Mean	Precipitation
June	35	19	27	128
July	35.5	19.5	27.5	234
August	36.6	19.8	28.5	233
September	35	19	27	223
October	35.5	18	26.5	132
December	34	17	26	145
Average	35.5	18.9	27.2	183

Parcel management

The grassland were established in July 2016, the sowing of cv. Cobra, Mulato II and Cayman, (*Urochloa*) were carried out in furrows at a separation of 50 cm and between plants at 5 cm, at a planting density of 8 kg ha^{-1}, while stargrass (*Cynodon plectostachyus*) was with plant material (stolons) to winnow. 48 experimental units of 10 x 10 m distributed in a randomized block design with three replications were used.

The plots were not fertilized, nor was irrigation applied throughout the experimental phase. At the beginning of the experiment, a uniform grazing was carried out in all the experimental units. The treatments were the grass genotypes: Cobra, Mulato II, Cayman and star grass and two grazing frequencies (FP: 28 and 35 d), with two intensities: severe (10 cm) and light (15 cm). Calves of approximately 180 to 200 kg SS, approximately F1 Brown Swiss x Brahman were used in each plot, only as defoliators, until grazing intensity was reached. The animals remained from 4 to 8 h depending on the treatment.

Forage yield

To evaluate the seasonal and annual forage yield, one day before each grazing, two fixed quadrants of 50 x 50 cm were randomly placed in each repetition, which were harvested at the corresponding intensity and frequency. Subsequently, the weight of the fresh forage was recorded, placed in paper bags and dried in a forced air stove (Memmert model UF 260) at a temperature of 55 °C, for 72 h. The dry weight of the forage was recorded and the yield per unit area (kg DM ha^{-1}) was determined.

Morphological components

From the green forage harvested to estimate forage yield, a subsample of approximately 20% was taken, separated into the components: leaf and stem and placed in labeled paper bags and dried in a forced air stove at 55 °C , for 48 hours or until constant weight was reached and weighed on a Scout® Pro brand digital scale.

Leaf:stem ratio

The leaf: stem ratio was determined from the sample used for the morphological components and was obtained by dividing the yield of the leaf component by the yield of the stem.

Crude protein

To determine the crude protein, the leaf and stem morphological composition sample was ground (1 mm diameter mesh). Subsequently, subsamples were taken for protein determination using the Microkjendhal method (AOAC, 1990).

Statistical analysis

The data were analyzed using a completely randomized block design with a factorial arrangement of 2 x 2 treatments, using the Proc Mixed procedure (SAS, 2009), where the effects of interval between cuts, species and their interactions, were considered as fixed and the block effect as random. The multiple comparison of means of the treatments was performed using the adjusted Tukey test (α= 0.05).

Results and discussion

Forage yield

Table 2 shows a higher yield of the *Urochloa* hybrids compared to star grass, regardless of the frequency and intensity of grazing. Grazing frequency affected forage performance throughout the experimental period (p< 0.05), regardless of genotype and grazing intensity. Increasing the interval between grazing increased forage yield.

Table 2. Forage accumulation of hybrids of *Urochloa* (kg DM ha^{-1}) and star grass (*Cynodon plectostachyus*) subjected to different frequencies and intensities of grazing with bovines.

Frequency (days)	Intensity	Cobra	Mulato II	Cayman	Star grass
28	Severe	5 203 cA	4 498 cB	5 045 dA	3 405 dC
	Light	6 304 bcA	5 450 bcB	6 552 cA	3 786 cC
	Average	5 753	4 974	5 798	3 595

Frequency (days)	Intensity	Cobra	Mulato II	Cayman	Star grass
35	Severe	6 121 bA	5 697 abB	6 519 bA	3 337 bC
	Light	7 621 aA	6 970 aA	7 179 aA	4 271 aB
	Average	6 871	6 333	6 849	3 804
Average	Severe	5 662	5 097	5 782	3 371
	Light	6 962	6 210	6 865	4 028
SEM		92	83.7	89.1	66.9
Grazing frequencies (GF)		**	*	*	*
Grazing intensity (GI)		*	**	*	*
Interaction (GF x GI)		*	*	*	ns

Severe = 10 cm; light = 15 cm; ns= not significant; **= $p\leq 0.01$; *= $p\leq 0.05$, abc= different lowercase literal, in each column, indicate difference ($p< 0.05$); ABC= different capital letters, in each row, indicate difference ($p< 0.05$); SEM= standard error of the mean; ns= no significative.

Yield increased on average from 4 978 to 6 016 kg DM ha^{-1} with increasing grazing interval from 28 to 35 d ($p< 0.05$). The grass Cobra, Cayman and Mulato II obtained the highest yield in the frequency at 35 light intensity with an average of 6 962 kg DM ha^{-1}, while, in this management, the stargrass obtained the lowest yield with 4 028 kg DM ha^{-1}.

The opposite case occurred in the frequency at 28 of severe intensity obtaining the lowest performance in all genotypes with the following descending order: Cobra > Cayman > Mulato II > Star with 5 203> 5 045> 4 498> 3 405 ($p< 0.05$). Results similar to those of this investigation, presented by Rojas *et al*. (2018), when obtaining a greater accumulation as the cutting frequency and intensity increased, this when evaluating growth curves in Cobra grass obtaining the highest dry matter yield at 56 days at an intensity of 15 cm with 2 550 kg DM ha^{-1} and the lowest with intensity at 10 cm reaching a yield of 2 250 kg DM ha^{-1} ($p= 0.05$).

On the other hand, Garay-Martínez *et al*. (2018) obtained in different *Urochloa* cultivars a variable DM accumulation between cultivars and regrowth age ($p\leq 0.05$). During the season of greatest precipitation, the Mulato II cultivar presented the highest leaf accumulation with an average of 8 400 kg DM ha^{-1}, followed by the Cayman and Insurgente cultivars with 7 740 and 7 250 kg DM ha^{-1}, respectively; while, the cultivar H-17 registered the least accumulation with a value of 6 210 kg DM ha^{-1}.

These results are similar to those obtained by different authors (Martínez *et al*., 2008; Cruz *et al*., 2017a), in the *Brachiaria humidicola* cv. Chetumal, obtained a greater accumulation of dry matter by increasing the frequency and intensity of grazing, this indicates that, with frequent defoliation, the density of stems in the grassland is increased, which do not manage to intercept 95% of sunlight (Rojas *et al*., 2017).

On the contrary, with longer intervals the competition between plants for sunlight increases continuously, so that the grassland develops a low density of stems, with higher height and greater leaf area (Ramírez *et al*., 2010; Cruz *et al*., 2017b). In accordance with the above, Hirata and Pakiding (2004) state that grasses that undergo frequent grazing and severe intensities decrease forage yield up to 50%.

Morphological components

The frequency and intensity of grazing of a grassland influences the growth rate, production, botanical composition and quality. This indicates that it is important to consider not only the forage yield, but also the proportion of leaves in relation to the stems (Joaquín-Cancino *et al*., 2019). In the present investigation, there was an effect of grazing frequency and intensity ($p< 0.05$) on the component in the *Urochloa* and stargrass species (Table 3).

Table 3. Accumulation of morphological components of *Urochloa* hybrids (kg DM ha^{-1}) and star grass (*Cynodon plectostachyus*) subjected to different grazing frequencies and intensities with cattle.

Frequency (days)	Intensity	Leaves (kg DM ha^{-1})				Stems (kg DM ha^{-1})			
		Cobra	Mulato II	Cayman	Star grass	Cobra	Mulato II	Cayman	Star grass
28	Severe	3203cB	4 090cA	4209cA	1239bD	1977bB	405cD	858bC	2179bA
	Light	4096bB	4890bAB	5342bA	1534aD	2206aA	545cC	1179aB	2234bA
	Average	3 650	4 490	4 776	1 387	2 129	497	1 044	2 193
35	Severe	4213bB	4,675bB	5656bA	1323bD	1898bA	1025bB	847bC	2002bA
	Light	5323aB	5466aB	6342aA	1543aD	2286aA	1533aB	861bC	2733aA
	Average	4 768	5 071	5 999	1 433	2 130	1 267	822	2 358
Average	Severe	3 708	4 383	4 933	1 281	1 982	714	867	2 090
	Light	4 710	5 178	5 842	1 539	2 228	1 056	1 030	2 497
SEM		98.1	76.3	72.1	54.8	36.6	23.1	34.7	46.1
Grazing frequencies (GF)		**	*	*	*	*	*	*	*
Grazing intensity (GI)		*	**	**	*	*	*	**	*
Interaction (GF x GI)		Ns	ns	ns	ns	*	*	*	ns

Severe= 10 cm; light= 15 cm; **= $p\leq 0.01$; *= $p\leq 0.05$, abc= different lowercase literal, in each column, indicate difference ($p< 0.05$); ABC= different capital letters, in each row, indicate difference ($p< 0.05$); SEM= standard error of the mean; ns= not significant. These leaf yield results are similar to those reported by Ramírez *et al*. (2009).

The greatest accumulation of leaves occurred in the grazing interval at 35 light intensity in the Cayman species with 6 342 kg DM ha^{-1}, while, with this same management, star grass obtained the lowest yield with 1 543 kg DM ha^{-1} ($p< 0.05$). Inverse case with regard to the yield of stems, Stargrass and Cayman grass obtained the highest and lowest yield in frequency at 35 d and light intensity with 2 733 and 861 kg DM ha^{-1}, respectively ($p< 0.05$).

The change in the morphological composition was due to the handling frequency and grazing intensity that favored a greater growth of the leaves, which agrees with what was reported by Cruz *et al*. (2017a), found that the leaf increases its appearance in *Brachiaria humidicola* cv Chetumal when grazing with cattle at a frequency of 28 intensity of 13 to 15 cm in the rainy season with 7 271 kg DM ha^{-1} and less when it decreases the frequency and intensity with 4 734 kg DM ha^{-1}.

Those who mention that the proportion of the morphological components in the harvested forage decreases the leaf with increasing the interval between harvests, due to a greater growth of the stem, when the environmental conditions are favorable for the growth of the plants as it happens at the time of rains due to favorable climatic conditions for growth (Sage and Kubein, 2007).

The higher forage accumulation in the 35 d grazing interval compared to the 28 d grazing interval coincided with the greater number of leaves and stems. This behavior was observed by different researchers (Difante *et al*., 2011; Calzada *et al*., 2014; Rueda *et al*., 2016) who affirm that the age of the plant determines the distribution of dry matter in its different morphological components.

Leaf:stem ratio

In general, it is observed that the pastures of the genus *Urochloa* have a better leaf: stem relationship, compared to star grass (Table 4). Grazing frequency and intensity effect was presented, as well as its interaction, in all species ($p< 0.05$). The leaf: stem relationship was variable depending on the genotype and management given in the grassland, in frequency and grazing intensity.

Table 4. Changes in the leaf: stem relationship of hybrids of *Urochloa* and star grass (*Cynodon plectostachyus*) subjected to different grazing frequencies and intensities with cattle.

Frequency (days)	Intensity	Cobra	Mulato II	Cayman	Stargrass
28	Severe	1.6 Cc	10.1 aA	4.9 cB	0.6 bD
	Light	1.9 Bc	9 aA	4.5 cB	0.7 aD
	Average	1.7	9	4.6	0.6
35	Severe	2.2 Ac	4.6 bB	6.7 bA	0.7 aD
	Light	2.3 Ac	3.6 bB	7.4 aA	0.6 bD
	Average	2.2	4	7.3	0.6
Average	Severe	1.9	6.1	5.7	0.6
	Light	2.1	4.9	5.7	0.6
SEM		0.3	0.4	0.3	0.2
Grazing frequencies (GF)		*	*	**	*
Grazing intensity (GI)		**	**	**	*
Interaction (GF x GI)		*	*	*	ns

Severe= 10 cm; light= 15 cm; ** = $p\leq 0.01$; * = $p\leq 0.05$, abc= different lowercase literal, in each column, indicate difference ($p< 0.05$); ABC= different capital letters, in each row, indicate difference ($p< 0.05$); SEM= standard error of the mean; ns= not significant.

The leaf: stem ratio in Mulato II grass was the highest ($p< 0.05$) when grazing every 28 of severe intensity with a leaf: stem ratio of 10.1 and less in star grass, regardless of the frequency and intensity of grazing with 0.6 ($p< 0.05$). This same behavior is reported by Cruz *et al*. (2017a) in the grass *Brachiaria humidicola* cv. Chetumal as leaf: stem ratio increases as grazing frequency and intensity increases.

The Cobra and Cayman grass increased in the leaf: stem ratio at a higher frequency and light intensity from 1.7 and 4.6 to 2.2 and 7.3, respectively. The higher leaf: stem ratio was due mainly to the management given in the grassland, as demonstrated by Ramírez *et al*. (2009), when increasing the cutting age from 3 to 7 weeks, they found a lower leaf: stem relationship in Mombaza grass (*Panicum maximum* Jacq.).

The highest values in the leaf: stem ratio were associated with the sampling technique, since forage harvesting was carried out at predetermined grazing heights, which avoided harvesting a greater number of stems, which are located near the surface of the soil (Cruz *et al*., 2017b). In addition, when considering the stoloniferous growth habit of star grass compared to the tufts of the *Urochloa*, the lower leaf: stem ratio and the absence of senescent material are explained, since it was concentrated in the lower strata of the grassland.

Crude protein

The crude protein of leaf and stem of hybrid *Urochloa* and star grass grasses, when varying the frequency and intensity of grazing is observed in Table 5. In general, the highest crude protein in leaf, in all grasses, was found in the severe grazing and intensity at 28 d with 20, 20, 18 and 10% of crude protein in the Cobra, Mulato II, Cayman and star grass pastures, respectively ($p< 0.05$).

Table 5. Crude protein content (%) of hybrids of *Urochloa* and star grass (*Cynodon plectostachyus*) subjected to different frequencies and grazing intensities with cattle.

Frequency (days)	Intensity	CP leaves (%)				CP stems (%)			
		Cobra	Mulato II	Cayman	Star grass	Cobra	Mulato II	Cayman	Star grass
28	Severe	20 aA	20 aA	18 aB	10 aC	13 aA	12 aA	10 aB	5 aC
	Light	19 aA	18 bA	16 bB	9 bC	11 bA	10 bA	9 bB	4 Bb
	Average	19.5	19	17	9.5	12	11	9.5	4.5
35	Severe	15 bB	17 cA	15 cB	7 cC	12 abA	11 abA	7 cB	4 bC
	Light	14 bB	16 dA	14 dB	6 dC	10 cA	10 cA	6 dB	4 bC
	Average	14.5	16.5	14.5	6.5	11	10.5	6.5	4
Average	Severe	17.5	18.5	16.5	8.5	12.5	11.5	8.5	4.5
	Light	17	17	15	7.5	10.5	10	7.5	4
EEM		2.5	3.2	3.4	1.5	2.1	1.9	1.6	1
Grazing frequencies (GF)		*	*	**	ns	*	*	*	ns
Grazing intensity (GI)		**	**	**	*	*	*	**	*
Interaction (GF x GI)		*	*	*	ns	*	*	*	ns

Severe= 10 cm; light= 15 cm; **= $p\leq 0.01$; *= $p\leq 0.05$, abc= different lowercase literal, in each column, indicate difference ($p< 0.05$); ABC= different capital letters, in each row, indicate difference ($p< 0.05$); SEM= standard error of the mean; ns= not significant.; CP= crude protein.

While, at higher frequency and light intensity, there was a decrease in the percentage of crude protein, independently of the pastures evaluated with the following descending order: Mulato II, Cobra, Cayman and star grass with 16, 14, 14, 6, respectively ($p< 0.05$). On the other hand, the amount of protein in stems was highly variable depending on the type of grass and management given in the grassland. The highest percentage is reported in Cobra grass, with a frequency of 28 of severe intensity with 13% of crude protein, while the lowest was in star grass in the frequency at 35 d with 4% of crude protein (p< 0.05).

Hernández *et al*. (2002) have indicated that the environment and management in terms of grazing frequency and intensity, are the main factors that affect the yield, quality and persistence of a grassland. Therefore, when a grassland is grazing frequently and at a severe intensity, forage production is lower, but with higher digestibility and crude protein (Ramírez *et al*., 2009), since the largest amount of forage harvested is leaf.

Whole plant in grass Estrella-Molina *et al*. (2015), reported 11.8% protein very similar in protein content in this research. On the other hand, Villalobos and Arce (2014) report the average crude protein content in star grass with 20.27%. This result is greater than that reported in this investigation, however, the crude protein varies depending on the climatic conditions and management given in the grassland (Rojas-García *et al*., 2018)

Cano *et al*. (2004) reported a lower crude protein concentration, with increasing cutoff frequency. On the other hand, Vergara and Araujo (2006) state that there is an increase in crude protein in *Brachiara humidicola* grass by decreasing the cutting interval. Cruz *et al*. (2017a) mention in Chetumal grass, a decrease in the interval between grazing in the crude protein content, such behavior is due to the fact that, in the plant, the older the cell wall accumulates, which is known as fiber.

They observed that the amount of crude protein was higher at the younger sprout ages resulting in more frequent cuts as in this research. This behavior has been observed by other researchers (Lara and Pedreira, 2011; Rojas-García *et al*., 2018) who mention that the nutritional quality of forages is closely linked to their maturity at harvest and the environmental conditions where the crop is developed.

Conclusions

The highest contribution of leaf, leaf: stem and crude protein ratio is found in a greater proportion in the hybrids of *Urochloa* (Cobra, Mulato II and Cayman) and less the stargrass, independently of the management given in the grassland. The greatest forage accumulation was obtained by grazing at a light intensity of 15 cm in height every 35 d and with a severe intensity of 10 cm, the crude protein content was higher. It is recommended to continue with this type of research where a longer time was evaluated and with it, expand the panorama in the management decisions of a grassland in the dry tropics.

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