Scientific Paper

Productive performance of growing male cattle in two animal husbandry farms of the Cesar valley, Colombia

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Abstract

Objective: To evaluate the performance of productive indicators in growing male cattle in two animal husbandry farms under the management conditions of the Cesar Valley region, in Colombia.

Materials and Methods: Growing male cattle, of the commercial breed Brahman, were used. The study lasted nine months. Grazing systems of *Bothriochloa pertusa* (L.) A. Camus were used, in two farms, without the application of irrigation or fertilization. The forage availability, live weight, mean daily gain and bromatological composition were evaluated as indicators.

Results: In both farms, the highest dry matter yields were found in the rainy season. With the beginning of the dry season, the forage production decreased. Mean daily gain of 425 and 428 g animal^{-1}day^{-1} in the rainy season, and of 112 and 167 g animal^{-1} day^{-1} for the dry season were obtained in the farms La Providencia and La Unión, respectively. The average protein values varied between 7 and 9 %. Meanwhile, neutral detergent fiber and acid detergent fiber increased in the dry season with regards to the rainy season. The feeding balances indicated metabolizable energy deficit during the dry season and, in both seasons, in the minerals Ca, P, Na, Cu and Zn.

Conclusions: The results indicate that *B. pertusa* is a pasture with important DM yields in the rainy season, but the utilization of other feeding strategies is necessary in the dry season to cover the requirements and prevent weight losses in the animals.

Keywords: *Bothriochloa pertusa*, weight gain, green forage, minerals

Introduction

In the Caribbean region of Colombia double-purpose animal husbandry systems prevail, which show genotypes and management adapted to the edaphoclimatic conditions of the region, and with a tradition in this economic activity (Tapia-Coronado *et al.,* 2019). Cattle feeding depends, almost exclusively, on the forage produced in natural grasslands, affected by rainfall seasonality. The hydrological dynamics of the zone and the spatial and temporary variability of the forage, along with an extensive management, have caused a negative environmental impact on the region (FAO, 2019; Vélez-Terranova, 2019).

Under these conditions, the productive indexes are low. Among them, the weight gain of growing male cattle, which require a long time to reach slaughter weight (FEDEGAN, 2018). This category is economically important. However, the absence of feeding strategies during the dry season, which prevent overgrazing and increase productivity, stand out (Argüello-Rangel *et al*., 2019).

In the animal husbandry areas, *Bothriochloa pertusa* (L.) A. Camus prevails, which shows seasonal restrictions in the dry matter yield (Cajas-Girón *et al*., 2012). This pasture shows high production of stolons and viable seeds, with a wide adaptation to low-fertility soil conditions in areas of scarce rainfall and good tolerance to trampling, characteristics that provide it with higher adaptation capacity and better relative resilience, compared with other grass species present in the region (Doncel *et al.,* 2016; Portela-Pérez and Brito-Martínez, 2018). Yet, its acceptance by farmers is controversial, aspect that needs to be evaluated in order to have arguments that support its advantages and disadvantages.

From the above-explained facts, this research was conducted to evaluate the performance of productive indicators in growing male cattle in two animal husbandry farms, under the management conditions of the Cesar valley region, in Colombia.

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Materials and Methods

Description of the research sites. The studies were conducted in the animal husbandry ecoregion of the Cesar Valley, in the Cesar Department, Colombia. The farms La Providencia (10º 08,201″ N, 73º 14,391″ W) and La Unión (09º 54,067″ N, 73º 14,983″ W), representative of the productive systems of the region, with altitudes between 100 and 160 m.a.s.l., respectively, and relief of flat topography, were selected.

Climate. The experimental area is identified as Caribbean and Inter-Andean Valleys region, with plant formation of tropical dry forest and alluvial plains. The climate shows two well-defined seasons: rainy (RS) and dry (DS), with mean annual rainfall of 1 550 mm. Table 1 shows the climate data during the experimental stage, which were obtained from the Meteorological Station Motilonia, located in the study region.

Soil characteristics. The soils of the farms were evaluated according to the techniques described in the procedure handbook for soil, water and plant tissue analysis (IGAC, 2009). The samples were taken at the beginning of the study, between 0 and 20 cm of depth. As indicators, pH, OM, macroelements (Ca, Mg, K, Na, P, S), microelements (Cu, Fe, Mn Zn, B), effective cation exchange capacity and electrical conductivity, were determined (table 2).

La Providencia showed a soil with loamy texture, alkaline pH, low Fe, moderate S, Mg and B and high P, Ca, K and N concentrations. Meanwhile, La Unión showed a soil of sandy texture, slightly acid pH, low P, S, Mg, K, Na y B, moderate Ca and high Fe contents.

Characterization of the farms. For the characterization and selection of the farms, the authors took into consideration the information available in the database of the Federation of Ranchers-National Fund of Livestock (FEDEGAN-FNG, for its initials in Spanish) and the contribution by technicians and officials of the Municipal Units of Agricultural Technical Assistance, who have integral knowledge of the farms, due to the advisory and supervision they carry out. In the evaluations it was adopted as criterion to favor the representativeness of the system, to preserve the technological aspects of each farm, and non-intervention in the zootechnical management.

The selected farms have, among their productive processes, the growing male cattle husbandry systems, with predominance of the commercial breed Brahman (Zebu). The study lasted nine months, framed in two seasons: RS (May-October) and DS (November-February). Grazing systems of grass monocultures were used, represented by *B. pertusa* (purity between 95 and 97 %), typical of the Caribbean region, with the application of neither irrigation nor fertilization.

In both farms, the grazing system was rotational in the RS. The paddocks were managed without defined permanence time (between 4 and 6 days), and the changes of paddock were determined through visual appreciation of the availability. In the DS, the system was continuous, with all the paddocks available for the animals, without using supplements or mineral salts. The live weight (LW) of the animals was transformed into large animal units per hectare (LAU ha^{-1}), considering 450 kg as

Table 1. Climate data of the experimental area.

Month	Rainfall, mm	Temperature, °C	Humidity, %
May	238,9	28	76
June	190,6	28,3	70,5
July	110,5	27,9	70,3
August	114,5	27,9	68,2
September	51,1	27,9	66
October	431,5	27	69,6
November	50,3	27,3	69,8
December	41,4	27,9	61,5
January	0	29	45,7
February	28	30	41,9

Table 2. Soil characterization in the study farms.

Indicator	La Providencia	La Unión
Texture	Loamy	Sandy
pH	9,0	6,4
OM, %	1,5	1,4
P, mg kg^{-1}¥¥	39,2	4,1
S, mg kg^{-1}¥¥	15,5	5,9
Ca, cmol(+) kg^{-1}¥	14,7	3,9
Mg, cmol(+) kg^{-1}¥	2,2	0,7
K, cmol(+) kg^{-1}¥	0,5	0,1
Na, cmol(+) kg^{-1}¥¥	1,5	0,1
ECEC, cmol(+) kg^{-1}	18,2	4,8
EC, dS m^{-1}	0,7	0,2
Fe, mg kg^{-1}¥¥	10,0	60,0
Cu, mg kg^{-1}¥¥	2,9	1,1
Mn, mg kg^{-1}¥¥	0,9	1,0
Zn, mg kg^{-1}¥¥	0,5	0,8
B, mg kg^{-1}¥¥	0,3	0,1

¥¥Available ¥¥Exchangeable
CE: electrical conductivity, ECEC: cation exchange capacity

reference unit. Due to the differences shown by the farms in the number of animals, the age and LW were independently analyzed.

Animals and management. In the farm La Providencia, 34 animals were used, with average weight of 191,9 ± 25,1 kg and ages between 16 and 18 months. The grazing area was 10 ha, divided into 11 paddocks (0,91 ha), and an initial stocking rate of 1,45 LAU/ha. In La Unión, 20 animals were used, with average weight of 115,9 ± 16,0 kg, and ages between 10 and 12 months. The grazing area had 6 ha, divided into five paddocks (1,2 ha) and an initial stocking rate of 0,86 LAU/ha.

In the two farms, the grazing areas were delimited by perimeter fences with barbed wire, and the paddocks, by electrical fences.

In both entities, the animals were clinically healthy upon the physical examination and had the vaccination program established in the region (foot-and-mouth disease, hemorrhagic septicemia, malignant edema, symptomatic carbuncle) and the control of endoparasites and ectoparasites updated.

Forage availability. To estimate the dry matter (DM) availability, the methodology described by Martínez *et al.* (1990) was used. The evaluations were made the day before the entrance of the animals in the paddocks and the monthly values corresponded to the average of the samplings conducted during each month.

Bromatological composition. During the monthly determination of availability, representative samples of the pasture were taken (300 g) to estimate its quality, manually simulating the selection made by the grazing animal. The DM content was determined through dehydration until reaching constant weight in an air-forced stove at 60 ºC in the laboratory of Motilonia. The samples corresponding to the same month were homogenized, and a representative portion was sent to the laboratory of CORPOICA, in Bogota, to determine the bromatological composition, according to the procedure of the Colombian Agricultural Institute (ICA, 1989): CP, NDF, ADF, ash (ASH), P, Ca, Mg, Na, K, S, Fe, Cu, Mn and Zn.

Determination of LW. The animals were individually weighed, with previous fasting of 12 hours, and monthly frequency. A portable mechanic scale, Prometálico® trademark, Model CUI 1500-E, with capacity of 1 500 ± 0,01 kg, was used. The mean daily gain (MDG) was quantified, expressed in g animal^{-1} day^{-1}, from the differences of initial and final LW.

Feeding balance. The nutritional requirements were retrospectively determined, from the LW

and MDG in each month. As they were animals fed only with pastures, which were permanently in the grazing areas, the DM requirements were considered equivalent to the ingestion capacities (IC), determined by the CALRAC® program, version 1.0 (1996) for beef cattle, just like the requirements for metabolizable energy (ME), crude protein (CP), Ca and P. The other macro- and microminerals were estimated according to the rules established by the National Research Council (NRC, 2000). The ME of *B. pertusa* during the evaluated months was retrospectively determined through the CALRAC® *program. The data* were transformed to MJ, multiplying the values by 4.14.

Statistical analysis. The results were recorded in an Excel database. In the analysis of the results descriptive statistics was applied to calculate the mean and standard deviation through the statistical package InfoStat®*, free version 1.1 for Windows*.

Results and Discussion

When evaluating the DM availability of *B. pertusa* in the farms (table 3), the results showed higher yield in La Providencia, which could be ascribed to the better physical-chemical and fertility conditions shown by loamy soils, compared with those of sandy texture (Portela-Pérez y Brito-Martínez, 2018).

In both farms, the highest forage productions occurred in the rainy season. These values are similar to the ones reported by Piñeros *et al.* (2011), who stated that in the Colombian Caribbean region the grasslands dominated by this grass show during the RS DM availabilities that can be considered acceptable. It does not occur like that in the DS, in which the reduction in the forage availability causes productive limitations in the animals.

Tapia-Coronado *et al.* (2019) agree that one of the factors with higher influence on the weight gain of cattle in the tropic is climate seasonality, because the forage deficit leads to decreases in productivity per area unit.

The bromatological composition of the grassland is shown in table 4. The ME contents showed that, in the RS, the pasturelands reach higher values with regards to the DS, in both farms the performance was similar.

The DM percentages were linked to the season and the RS values were lower with regards to the DS. As average, the crude protein content was similar in both farms, with slightly higher percentages in the rainy season compared with the dry season. Meanwhile, the NDF and ADF increased in the DS.

A similar performance was reported by Tapia-Coronado *et al.* (2019), when evaluating the productive potential of twelve genetic forage materials for the dry savannas of the Colombian Caribbean, which included *B. pertusa*.

Patiño-Pardo *et al.* (2013) state that these reductions in the bromatological indicators, along with the decline in availability, make *B. pertusa* show limitations to maintain the milk production and weight gain during the DS.

No remarkable differences were recorded in the mineral composition between the farms. However, La Providencia showed the highest P, K and Fe contents; while, in La Unión these corresponded to Mn and Zn. The ASH, Ca, Mg, Na and S values were similar in both farms. The season did not show a defined performance. There were trends to being higher in the RS for K, and in the DS for Fe, Mn and Zn in La Providencia. Yet, in La Unión the highest percentages corresponded to Mn in the RS, and to Zn in the DS.

When considering the criterion expressed by McDonald *et al.* (2013) about the content of minerals in tropical forages, *B. pertusa* showed low percentages of P, Ca and Na, with deficient values of Cu and marginal values of Zn.

According to Rajkumar *et al.* (2012), the variations in mineral percentages in the same forage depend on several factors. Among them, the properties of the soil where it is developed, the quantity and

Table 3. Dry matter availability per season of the year (kg DM ha^{-1} $rotation^{-1}$).

Season	Farm	
	La Providencia	La Unión
Rainy	1 272,2	882,2
Dry	978,8	706,2
Total	2 251,0	1 588,3

Table 4. Bromatological composition of *B. pertusa* in the farms.

Indicator	La Providencia		La Unión	
	RS	DS	RS	DS
ME, MJ/kg DM	8,8	7,0	9,0	7,5
DM, %	25,2	38,2	27,1	37,4
CP, %	8,5	7,1	8,8	7,9
NDF, %	68,4	65,8	69,9	66,4
ADF, %	38,2	43,3	39,1	43,9
ASH, %	13,4	13,3	12,1	13,1
P, %	0,3	0,3	0,2	0,2
K, %	1,6	1,4	1,1	1,2
Ca, %	0,4	0,4	0,4	0,4
Mg, %	0,2	0,2	0,2	0,2
Na, %	0,1	0,1	0,1	0,1
S, %	0,4	0,4	0,4	0,3
Fe, mg/kg DM	226,6	241,5	195,8	194,2
Cu, mg/kg DM	6,6	6,1	6,2	7,4
Mn, mg/kg DM	58,6	60,9	68,6	65,5
Zn, mg/kg DM	25,0	26,2	27,8	29,2

distribution of rainfall and, especially, on the management received by the soil-plant-animal system.

Figure 1 describes the LW increases in the farms during the research. The interval comprised between 0 and 180 days characterized the rainy season. The interval from 181 to 270 days, grouped the dry season. The LW dynamics indicated a growing increase for the RS, and a more discreet increase in the DS, with losses in February (150 days).

According to Iraola *et al.* (2017), in the systems under grazing conditions, the analysis of the curves that describe the performance of LW, allows to make technical and commercial projections of the herd, which contribute to boosting beef production.

These responses were directly related to DM availability and the effect of season, because, in both farms, the highest forage quantity was reached in the RS. Similar results were referred by Torregroza *et al.* (2015) with *Brachiaria* híbrido cv. Mulato II in the Sinú valley, Colombia. Also Iglesias *et al.* (2014) reported similar data, with different cattle genotypes in the initial stage of fattening in Cuba. These studies corroborate that the productive responses of cattle are linked to the forage availability.

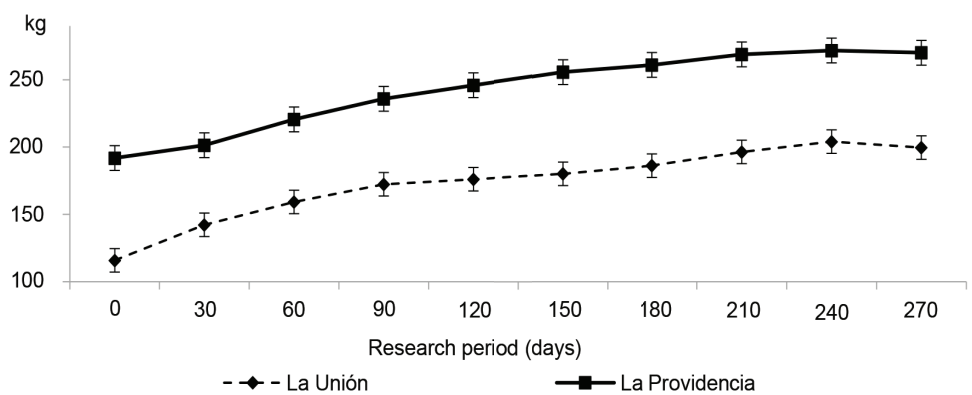

Figure 1. Performance of LW in the studied farms.
0-180 days rainy season 181-270 days dry season

According to Tapia-Coronado *et al*. (2019), the pasture production sustains animal husbandry systems during the RS. However, in the DS, which occurs between November and April, animal husbandry experiences the effects caused by the reduction in forage offer and quality.

Mejía *et al*. (2013) report that in the Caribbean region of Colombia during the DS, forage production can decrease between 30 and 60 %, and generate weight losses between 20 and 40 kg animal^{-1}día^{-1}, which determines the low productive indexes that are reported in animal husbandry during this season.

The link between the LW performance and forage availability was observed in the gain found in each season (table 5). The results of the RS compared with those of the DS were three times higher.

These results are higher than the ones referred by Rivera-Herrera *et al*. (2017) for traditional systems, based on pastures in the Caribbean region (0,130-0,250 kg animal^{-1} day^{-1}). Nevertheless, they are lower than those reported by Iraola *et al*. (2016), who indicate gains between 0,573 and 0,622 kg animal^{-1} day^{-1}, in Holstein x Zebu yearlings, under restricted grazing with herbaceous legumes complemented with corn (*Zea mays* L.) y and sugarcane (*Saccharum officinarum* L.).

The decrease of the pasture availability and quality during the DS, affects the DM intake of ruminants, which originates weight loss and increase in the necessary time for growing animals to reach slaughter weight (Iraola *et al*., 2013).

In this sense, the feeding balances indicated that, in both farms, during the dry season, the pasture contributions did not cover the ME requirements. These deficits were also recorded independently from the season, for Ca, Na, Cu and Zn, and for P in the case of La Unión (table 6). Meanwhile, no deficits were found of the other evaluated nutrients (CP, K, Mg, S, Fe and Mn).

In the Cesar valley region there are no studies that allow to determine the productive responses of growing male cattle, when these deficient minerals are guaranteed. However, the results confirm the need to include mineralized salts in the diets to optimize the nutrition of growing cattle in such region.

The increase of LW of the cattle was 78,2 and 83,8 kg^{-1} animal^{-1}; while the beef yield was 265,9 and 279,3 kg ha^{-1} for the farms La Providencia and La Unión, respectively. The best productive response in La Unión could have been related to the stocking rate variations (0,86 to 1,52 LAU ha^{-1}), because this group of animals was younger and had lower weight compared with La Providencia, in which the variations were from 1,45 to 2,02 LAU ha^{-1}.

The season also showed a marked effect on this indicator, because in both farms higher increases were obtained, always in favor of La Unión, during the RS with regards to the DS. Torregroza *et al.* (2015) state that these responses are linked to the initial stocking rates, because when they are high, productivity per animal tends to decrease in time (table 7).

Conclusions

B. pertusa is a plant genetic resource of favorable conditions for animal husbandry systems in the Cesar Valley region, due to its broad range of adaptation to soils and its dry matter yield in the rainy season.

The utilization of *B. pertusa* during the dry season requires feeding strategies aimed at covering the lack of dry matter availability, during the periods of forage lack in pasture-based systems. In addition, the deficit of minerals in this type of system was confirmed.

Table 5. Performance of weight gain in the animals.

Indicator	Farm	
	La Providencia	La Unión
Initial LW, kg	191,9 (25,1)	115,9 (16,1)
Final LW, kg	270,1 (48,7)	199,7 (28,3)
Weight increase, kg^{-1} animal^{-1}	78,2 (28,2)	83,8 (21,6)
MDG RS, kg^{-1} animal^{-1} día^{-1}	0,425 (49,8)	0,428 (28,4)
MDG DS, kg^{-1} animal^{-1} día^{-1}	0,112 (56,3)	0,167 (46,2)

MDG RS: mean daily gain of the rainy season, MDG DS: mean daily gain of the dry season
( ) Values between parentheses correspond to the standard deviation

Table 6. Feeding balance of La Unión and La Providencia

Balance	ME, MJ kg DM^{-1}	CP, g	Ca, g	P, g	Mg, g	K, g	Na, g	S, g	Fe, mg	Cu, mg	Mn, mg	Zn, mg
La Providencia												
Rainy season												
Requirement	54,1	598	16,3	23,5	36,1	6,0	4,8	9,0	301	60	121	181
Contribution	54,5	601	15,6	23,9	94,3	12,8	1,7	12,3	1 225	40	353	150
Difference	0,5	3	**-0,7**	0,4	58,2	6,8	**-3,1**	3,3	923	**-21**	232	**-30**
Dry season												
Requirement	47,4	526	18,1	26,1	40,2	6,7	5,4	10,1	335	67	134	201
Contribution	47,0	527	16,7	26,2	94,1	12,2	2,6	13,4	1267	40	412	189
Difference	**-0,4**	1	**-1,3**	0,1	53,9	5,5	**-2,7**	3,3	932	**-27**	278	**-12**
La Unión												
Rainy season												
Requirement	44,3	492	18,7	13,0	4,8	28,8	3,8	7,2	240	48	96	144
Contribution	44,5	494	18,4	11,6	11,1	52,9	1,3	11,1	930	29	334	131
Difference	0,2	2	**-0,4**	**-1,4**	6,3	24,1	**-2,5**	3,9	690	**-18**	238	**-13**
Dry season												
Requirement	44,7	458	21,0	14,6	5,4	32,4	4,3	8,1	270	54	108	162
Contribution	41,2	462	20,9	14,2	10,9	57,7	2,2	11,2	1065	49	333	148
Difference	**-0,5**	3	**-0,1**	**-0,4**	5,5	25,4	**-2,1**	3,1	795	**-5**	225	**-14**

Table 7. Effect of season on the stocking rate (LAU ha^{-1}).

Farm	Rainy season			Dry season		
	Start	October	Increase	November	February	Increase
La Providencia	1,45	1,93	0,48	1,93	2,02	0,09
La Unión	0,86	1,36	0,50	1,36	1,52	0,16

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Authors' contribution

- Belisario Antonio Roncallo-Fandiños. Conducted the experiments and data collection. In addition, prepared the paper for its publication
- Félix Ojeda-García. Conceptualized the research idea and supervised the research activity.
- Mildrey Soca-Pérez. Carried out the statistical analysis. Participated in the writing and revised the manuscript.

Conflicts of interests

The authors declare that there are no conflicts of interests among them.

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