Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 09, Issue, 10, pp. 30924-30928, October, 2019

RESEARCH ARTICLE OPEN ACCESS

PERFORMANCE OF NELLORE HEIFERS ON DEFERRED UROCHLOA *BRIZANTHA*PASTURE FERTILIZED WITH NITROGEN

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ARTICLE INFO

Article History:
Received 09th July, 2019
Received in revised form
28th August, 2019
Accepted 17th September, 2019
Published online 30th October, 2019

Key Words:
Deferment forage. Digestibility.
Intake. Nitrogen fertilization.
Weight gain.

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ABSTRACT

The aim of this study was to evaluate the effects of different levels of nitrogen in deferred *Brachiaria* (Syn.*Urochloa*) *brizantha* cv. Marandu pastures on the intake, digestibility, and performance of Nellore heifers. A completely randomized design was adopted, with four treatments (nitrogen levels) and four replicates (number of fertilized paddocks). Initially, 48 Nellore heifers with an average age of 8 months and with an initial body weight of 179 kg were distributed at the rate of three animals per paddock into all treatments in a continuous grazing system with variable stocking rate. The intake and digestibility of crude protein and total digestible nutrients increased linearly with the nitrogen levels. The application of nitrogen had a quadratic effect on weight gain per area and weight gain per area per day, with maxima at 99 kg N.ha^{-1} for both gains. The intake and digestibility of nutrients are crucial to the animal performance, and fertilized deferred pastures provide higher intake and digestibility of crude protein and total digestible nutrients. Animal performance is better in the initial period of grazing due to the positive effects of nitrogen fertilization on forage.

Citation: Poliana Batista de Aguilar, Fábio Andrade Teixeira, Fabiano Ferreira da Silva, Aureliano José Vieira Pires, *et al.* 2019. "Performance of nellore heifers on deferred urochloa brizanthapasture fertilized with nitrogen", *International Journal of Development Research*, 09, (10), 30924-30928.

INTRODUCTION

The creation of the pasture system is the most used in Brazil, mainly due to the territorial extension of the country, and is the simplest form of management and lowest cost available. For these reasons, the pastures are essential in the production ofbovine, Brazil has the largest commercial herd in the world with about 199 million animals (Anualpec, 2013).Despite the advantages of the pasture production system, climate seasonality, with period and dry seasons, also entails stational production with high forage production in the period season and low production during the dry season. The great challenge of beef production systems in pastures is the use of knowledge and technological solution to raise productivity and product quality in a sustainable manner. To this end, maximize animal performance and optimize the use of basal forage resources consist of the main objectives of management strategies to be adopted (Reis *et al*. 2012). Among the alternatives to offset the forage production seasonality, deferment has shown to be promising, as it is a technique of low cost and easy to adopt (Euclides *et al*. 2007).

Deferment is a strategic pasture management practice that consists of selecting certain areas property and exclude it from the grazing, usually in late summer, with the objective of guarantee forage accumulation to be used, under grazing, during the period of scarce resource forage (Santos, 2009).The forage plants most suitable to pasture deferment are those with low accumulation of stems and good retention of green leaves, which result in lower reductions of the nutritional value over time. In this scenario, the species of the genus *Brachiaria* Urochloa have stood out (Euclides *et al*. 2007), especially Urochloa *brizantha* cv. Marandu. The aim of this study was to evaluate the application of different levels of nitrogen on deferred *Urochloabrizantha* cv. Marandu and its effects on the intake, digestibility, and performance of Nellore heifers.

MATERIAL AND METHODS

Statement of Animal Rights: All procedures were performed according to principles of animal experimentation approved by protocol 97/2015 by the Ethics Committee on Animal

Experimentation of the State University of Southwest Bahia, Brazil. The experiment was conducted on Boa Vista farm, located in Macarani-BA, Brazil (15°33′46″ S, 40°25′38″ W, 315 m altitude). The climate of the region is a tropical Aw type, with dry seasons, according to Köppen's classification. Temperature and precipitation data were collected with a thermometer and a pluviometer placed in the experimental area (Table 1).

into account. Based on the base-saturation values from the soil chemical analysis (Table 2), it was not necessary to correct the acidity(Ribeiro *et al*. 1999). Although the phosphorus contents were low (Cantarutti *et al*. 1999), no phosphate fertilization was applied, considering that the deferment practice is typically used in systems with a low technological level. The nitrogen (N) source utilized was urea (45% N), which was applied by broadcasting, according to the quantities established

Table 1. Monthly mean values for maximum and minimum temperatures (ºC) and precipitation (mm) during the experimental period

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
	Deferment period				Period of utilization				
Maximum temperature	30,1	26,2	25,6	24,0	26,8	30,0	29,6	32,4	30,8
Minimum temperature	16,7	16,2	15,2	14,5	16,5	17,6	17,9	18,9	20,2
Precipitation	19,0	67,6	28,0	33,0	25,0	30,0	64,0	22,0	30,0

Table 2. Chemical analysis of the experimental area

	pH	mg/dm^3	cmol$_c$/dm^3 of soil								%		mg/dm³
N level	(H_2O)	P	K^+	Ca^{2+}	Mg^{2+}	Al^{3+}	H^+	SB	CEC	CEC pH 7	BS	m	OM
0	5,7	1,0	0,3	1,6	1,3	0,3	2,4	3,2	3,4	5,8	54,3	7,5	3,58
50	5,8	1,0	0,4	1,7	1,3	0,3	2,6	3,4	3,7	6,2	54,3	7,8	3,91
100	5,8	1,0	0,5	1,5	1,3	0,2	2,2	3,3	3,5	5,7	57,0	6,8	3,75
150	5,6	1,0	0,3	1,4	1,2	0,2	2,6	3,0	3,2	5,8	51,0	7,3	4,12

SB sum of bases; *CEC* effective cation-exchange capacity; *CEC ph 7*cation-exchange capacity at pH 7,0;*BS* base saturation; *OM* organic matter.

Table 3. Availability of total dry matter and of the structural components, in kg DM. ha^{-1} of deferred Urochloa *brizantha* cv. Marandu pastures fertilized with nitrogen

		Nitrogen level (kg.ha^{-1})			
	Grazing	0	50	100	150
Availability of TDM	Initial	3,700	4,400	4,800	5,600
	Final	2,800	3,200	2,900	3,000
Availability of LBDM	Initial	1,000	1,300	1,700	1,900
	Final	485	703	688	567
Availability of SDM	Initial	873	1,300	1,800	1,900
	Final	539	1,000	771	803

ATDM availability of total dry matter; *LBDM* leaf blade dry matter; *SDM* stem dry matter.

The soil of the experimental area was a "Eutrophic Equivalent Red-Yellow Podzolic" type (Embrapa, 1999). Soil samples were collected before nitrogen fertilization, and the chemical analysis showed the following characteristics, in the 0-20 cm layer (Table 2). The experimental area consisted of 10 ha (hectares) established with *Urochloabrizantha* cv. Marandu for approximately 10 years, divided into 16 paddocks measuring approximately 0,6 ha each.

The nitrogen doses were distributed after being raffled in the paddocks. A completely randomized design was employed, with four treatments (nitrogen levels) and four replicates (number of fertilized paddocks), as follows: T1 = deferred pasture without nitrogen fertilization; T2 = deferred pasture with 50 kg N.ha^{-1}; T3 = deferred pasture with 100 kg N.ha^{-1}; and T4 = deferred pasture with 150 kg N.ha^{-1}. The experimental period from March 18 to November 07, 2013lasted 230 days, which consisted of 107 days of deferment, 15 days for the animals to adapt to the experimental diets, and 108 days for grazing and collection of data. The paddocks were sealed from the entry of the animals for 107 days, and were used again from July 21 to November 07, 2013, which is considered the dry period, appropriate for the start of use of deferred pastures in the region. To adjust the leaf blade allowance to the intended 3,6% of body weight, the amount of leaf blade accumulated during the deferment period was taken

in the treatments (111, 222, and 333 kg.ha^{-1}, referring to the N levels of 50, 100, and 150 kg.ha^{-1}, respectively). The doses were split into two applications: the first occurred on April 17, 2013, and the second on June 06, 2013, both during the rainy seasons. Evaluations of forage availabilitywere held every 27 days, in which the averages of the 1st (0 days of grazing) and 2nd (27 days of grazing) forage collections were considered the initial grazing period, while the averages of the 3rd (54 days of grazing) and 4th forage collection (81 days of grazing) were considered the final grazing period. To estimate the forage production, five samples were cut randomly from each paddock, 5 cm above the soil, using pruning shears and a 0,70 × 0,70 m square, with a total area of 0,49 m^2. All samples were weighed, and then homogenized and divided into representative sub-samples: one was separated into leaf blade, stem (stem+pseudostem), and dead material, considering that the proportion of each morphological component was expressed as a percentage of the total weight. The materials were conditioned in labeled paper bags and dried in a forced-air oven at 60 ºC for 72 h,for subsequent calculations. Availability of total dry matter and of the structural components are shown in Table 3. To evaluate the animal performance, 28 Nellore heifers with an average age of 8 months and an initial body weight of 179 ± 27 kg, were initially used, distributed at the rate of three heifers per paddock into all treatments.

Table 4.Chemical composition of the simulated-grazing material, in percentage of dry matter, and crude protein, in kg DM.ha^{-1}, of deferred Urochloabrizanthacv. Marandu fertilized with nitrogen

Simulated grazing					
		Nitrogen level (kg.ha^{-1})			
	Grazing	0	50	100	150
CP	Initial	4,56	5,52	6,47	6,65
	Final	7,27	6,68	7,97	9,05
NDF	Initial	70,23	68,57	66,90	67,86
	Final	67,04	69,06	66,82	67,21

CP crude protein; *NDF* neutral detergent fiber.

Table 5. Intake of dry matter and nutrients by Nellore heifers on deferred Urochloa *brizantha* cv. Marandu pastures fertilized with nitrogen

Intake	Nitrogen level (kg.ha^{-1})				CV%[a]	P[b]	RE[c]	$R^{2,d}$
	0	50	100	150				
TDM	3,1	3,7	3,7	3,9	19,7	0,055	$\hat{Y} = 3,6$	-
CP	0,30	0,35	0,39	0,43	27,0	0,011	$\hat{Y} = 0,299 + 0,0009x$	0,99
TDN	1,8	2,2	2,3	2,5	22,6	0,020	$\hat{Y} = 1,891 + 0,0041x$	0,93

[a]Coefficient of variation in percentage; [b]Probability of error; [c]Regression equation; [d]Coefficient of determination; *TDM* total dry matter (pasture + supplement); *CP* crude protein; *TDN* total digestible nutrients.

The continuous grazing system was adopted, with variable stocking rate, using put-and-take animals (Mott and Lucas, 1952) each treatment received two test animals and a variable number of maintenanceanimals, according to the forage availability. The heifers were fed a supplement composed of ground corn (58,3%), soybean meal (25,4%), post-weaning salt (8,3%), and urea + ammonium sulfate 9:1 (8%), in percentage of dry matter. The supplement was provided to 0.2% of body weight for all animals in all treatments, with the aim of achieving average daily gains 0,400 kg(NRC, 1996). The heifers were weighed at the beginning and end of the experimental period, after being deprived of feed for approximately 12 h. Conducted two intermediate weighing to the 51 days and to the 102 days for adjustments in the offer of leaf blade, in the amount of supplement supplied, and for evaluation of the animal performance. The evaluation of animal performance was made through of weight gain per area (WG.ha^{-1}) was calculated as the sum of the total weight gain divided by the paddock area, and WG.ha^{-1}.day^{-1} was calculated by dividing WG.ha^{-1} by the grazing period. The external marker purified, enriched lignin (LIPE) was used to estimate fecal production, according to the methodology utilized by Rodriguez *et al*. (2006). LIPE was offered to four animals per treatment, every 27 days, atone capsule per animal, for seven days, with two days for adaptation and regulation of the marker excretion flow, and five days for feces collection. Approximately 200 g of feces were collected per animal/day, directly from the rectal ampulla, and stored in a freezer at -10 ºC. The samples of feces were thawed, homogenized, pre-dried in a forced-air oven at 60 ºC for 96 h, and subsequently ground in a Wiley knife mill with 1 mm sieve, stored, and identified in plastic containers for later laboratory analyses. The LIPE was analyzed in the Animal Nutrition Laboratory of EV/UFMG, using a spectrophotometer with infrared light detector (FTIR) (model Varian 099-2243). Samples of dried feces ground to 1mm were pelleted by the KBrmethod, and the concentration of LIPE was determined.

Approximately 300 g of forage were collected every 27 days, in all paddocks, by the simulated-grazing method, where the forage was cut by hand, after observation the grazing of animals. During the LIPE supply and feces-collection days, a composite sample of the collected material was made per treatment, which was pre-dried in a forced-air oven at 60 ºC for 72 h, and ground in a Wiley mill with 1 mm sieve. Later, went determine the crude protein, according to the methodology described by Silva & Queiroz (2002). The neutral detergent fiber content corrected for ash and protein was determined according to Mertens (2002).The chemical composition of deferred Urochloa *brizantha* cv. Marandu pastures fertilized with nitrogen are shown in Table 4. To estimate the voluntary intake of roughage feed, the internal marker indigestible NDF (iNDF) was used. Samples of the feeds supplied (pasture and supplement) were incubated for 288 h, according to Casali *et al*. (2008), in duplicate, in the amount of 0,5 g, in non-woven fabric (TNT) mini-bags (density of 100 g.m²) measuring 5 × 5 cm, in the rumen of cannulated Holstein×Zebu crossbred steers fed a diet similar to the studied treatments, according to Casali *et al*. (2009). After they were removed from the rumen, the mini-bags were washed with warm water and acetone until it was clear, and then transferred to an oven at 105 ºC and weighed (Mertens, 2002) for the quantification of the iNDF contents. The apparent digestibility of forage (AD) of the nutrients was determined as described by Silva & Leão (1979). Analyses of variance were performed using the statistical significance level of 5%. The regression models of the studied variables were tested as a function of the applied nitrogen levels, and coefficients of determination were also observed. System for Statistical and Genetic Analyses (SAEG) was used for the statistical analyses (Ribeiro Jr. 2001).

RESULTS

The nitrogen levels had no effect (P>0,05) on the total dry matter intake (TDMI), which averaged 3,2kg.day^{-1}. The intakes of crude protein(CP) and total digestible nutrients(TDN) increased linearly (P<0,05) as the nitrogen levels were increased (Table 5). An increasing linear effect (P<0,05) of the nitrogen levels was found on the digestibilities of dry matter(DM), crude protein(CP), and total digestible nutrients(TDN) (Table 6). No effect (P>0,05) of the nitrogen levels was found on the final body weight, which averaged 203 kg. The average daily gain increased linearly (P<0,05) in the initial grazing period; in the final grazing period, however, the

Table 6. Digestibility coefficients of dry matter and nutrients of forage in Nellore heifers on deferred Urochloa *brizantha* cv. Marandu pastures fertilized with nitrogen

Digestibility	Nitrogen level (kg.ha^{-1})				CV[a]	P[b]	RE[c]	R[2,d]
	0	50	100	150				
DM (%)	52,3	53,2	58,6	58,5	9,0	0,003	$\hat{Y}$ = 52,042 + 0,0479x	0,85
CP (%)	55,4	54,4	63,4	64,4	14,0	0,006	$\hat{Y}$ = 53,978 + 0,0723x	0,79
TDN (%)	58,3	58,7	63,3	62,6	7,1	0,009	$\hat{Y}$ = 58,126 + 0,0348x	0,76

[a]Coefficient of variation in percentage; [b]Probability of error; [c]Regression equation; [d]Coefficient of determination; *DM*dry matter, *CP* crude protein; *NFC* non-fiber carbohydrates; *TDN* total digestible nutrients.

Table 7. Performance of Nellore heifers on deferred Urochloa *brizantha* cv. Marandu pastures fertilized with nitrogen

Performance	Nitrogen level (kg.ha^{-1})				CV[a]	P[b]	RE[c]	R[2,d]
	0	50	100	150				
IBW (kg)	175	178	189	170	-	-	-	-
FBW (kg)	198	205	215	193	15,7	0,246	$\hat{Y}$ = 203	-
Initial ADG	0,314	0,573	0,515	0,600	22,8	0,005	$\hat{Y}$ = 0,381 + 0,0016x	0,64
Final ADG	0,176	0,319	0,305	0,298	39,0	0,168	$\hat{Y}$ = 0,275	-
WGA (kg.ha^{-1})	71	180	175	169	13,2	0,001	$\hat{Y}$ = 76,375 + 2,3233x – 0,0117x²	0,92
WGAD (kg.ha^{-1})	0,656	1,667	1,624	1,555	13,2	0,001	$\hat{Y}$ = 0,7072 + 0,0215x – 0,000108x²	0,92

[a]Coefficient of variation in percentage; [b]Probability of error; [c]Regression equation; [d]Coefficient of determination; *IBW* initial body weight; *FBW* final body weight; *ADG* average daily gain; *WGA* weight gain per area; *WGAD* weight gain per area per day.

nitrogen levels did not influence (P>0,05) ADG, whose mean value was 0,275 kg.day^{-1}. A quadratic effect occurred (P<0,05) on total ADG, which had its maxima at 83 kg N.ha^{-1}, with approximately 0,337 kg.day^{-1} (Table 7). The nitrogen levels had a quadratic effect (P<0,05) on weight gain per area (WGA) and weight gain per area per day (WGAD), with maxima at 99 kg N.ha^{-1} for both gains, whose estimated values were 192 kg.ha^{-1} and 1,8 kg.ha^{-1}.day^{-1}, respectively (Table 7).

DISCUSSION

The lack of significant differences of total dry matter intake (TDMI) (Table 5) was possibly influenced by the similarity in the nutritional composition, especially regarding NDFap (Table 4), since high levels of NDF can limit the dry matter intake. Besides, the supplement was 0,2% body weight for all treatments, and it had no effects on the intake. However, the increasing intake of CP (Table 5) may be explained by the increase in the concentration of CP in the forage, resulting from the nitrogen fertilization (Table 4). The TDN intake, however, was possibly affected by the increase in CP intake.
Although the nitrogen levels did not interfere with the intakes of DM (Table 5), an additive effect of the supplement might have occurred, working in the improvement of the rumen microbiota, stimulating the activity of rumen microorganisms and thus increasing the digestibility of DM. Furthermore, the leaf blade availability enabled the selection of a more digestible material (Table 3). Concerning the digestibility of crude protein and total digestible nutrients (Table 6), the growing increase in the intake of these nutrients (Table 5) caused the digestibility to also be affected. Mateus *et al.* (2011) worked with Nellore bullocks on *Brachiariabrizantha* cv. Marandu deferred, and verified increased digestibility of DM, CP and TDN, with average values of 53,94; 50,93 and 57.,92 to the level of supplementation of 0,25% PC, respectively, confirming the results of this study. The similarity in final body weight (Table 4) can be explained by the similarity in the chemical composition of the forage (Table 4), in the intake of nutrients (Table 5), and in the availability of leaf blade (Table 3), which did not influence any treatment.

The average daily gain (ADG) in the initial grazing period (Table 7) was certainly caused by the positive effects of nitrogen fertilization, which provided a greater availability of leaf blade (Table 3), and by the nutritional quality of the forage (Table 4), which provided an intake of forage with better nutritive value in this period. Only the animals from the treatment without nitrogen fertilization could not reach the ADG of 0,400 kg.day^{-1} in the initial grazing period. These results can be attributed to the nutritional quality of the forage present in this treatment, which showed the lowest CP content (4,6%) as compared with the treatments fertilized with nitrogen, in addition to a high NDFap content (70,2%) (Table 4). Moreira *et al.* (2011) reported that nitrogen levels (75, 150, 225 and 300 kg.ha^{-1}), did not influence the GMD of the bullocks in pastures *Urochloadecumbens*. cv. Basilisk without deferral, registering averages of 0,551 and 0,679 kg.dia^{-1} in the first and second year, respectively, confirming the results obtained in this study. The lack of differences in ADG in the final grazing period (Table 7) can be explained by the similarity in the nutritional quality of the forage (Table 4), and reduced leaf blade availability in this period (Table 3). This probably led to the reduction of selective grazing, and consequently lower utilization of the nutrients available in the forage, thereby affecting the animal performance.

The quadratic effect on weight gain per area (WGA) and weight gain per area per day (WGAD) (Table 7) can be explained by the increase in the stocking rate, which, in turn, was justified by the high forage availability. The decrease in weight gain was certainly influenced by the forage quality, which possibly compromised the intake. As a consequence, these animals did not show elevated performance. Moreover, the first adjustment in stocking rate occurred at 51 days of grazing, and the new maintenance animals did not manage to showgain weight, due to low quality of available forage, which might have impaired the treatment with 150 kg N.ha^{-1}, as it received the largest number of animals. The intake and digestibility of nutrients are essential to the animal performance, and deferred and fertilized pastures provide greater intake and digestibility of crude protein and total digestible nutrients. Animal performance is better in the initial period of grazing due to the positive effects of nitrogen fertilization on forage.

Acknowledgments: The authorsthank Fundação de Amparo à Pesquisa do Estado da Bahia – BRAZIL.

Conflict of Interest: The authors declare that they have no conflict of interest.

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