Environmental effects on performance of progeny from different Nellore sires in Brazilian semiarid region

Fatores ambientais sobre o desempenho de progêniesde diferentes touros da raça Nelore no semiárido brasileiro

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SUMMARY

The aim of this study was to evaluate the influence of environmental factors on the performance of progeny from different Nellore sires in Brazilian semiarid region. Data on live weight, average daily gain and scrotal circumference of 741 animals categorized as OR (open registry) or PB (purebred) and born from 27 sires were collected from a commercial farm located in Varzelândia-MG. Evaluations were taken at 12 (yearling) and 18months of age. Data were analyzed using the least-squares method, considering the effect of pedigree (OR or PB), sire, year of birth, month of birth and calf sex in the model. There was a significant influence of the pedigree, sex, month of birth and sire on animal's performance until yearling age, whereas the performance traits at 18months were influenced only by the month of birth and sire (P<0.05). Therefore, environmental factors such as year, month of birth and calf sex are important sources of variation on calf performance from birth to18 months and it should be considered when comparing and selecting animals based on these traits.
Keywords: Average daily gain, month of birth, *Bos indicus*, genetic improvement, scrotal circumference

RESUMO

O objetivo deste trabalho foi avaliar a influência dos fatores ambientais sobre o desempenho das progênies de diferentes touros da raça Nelore no semiárido brasileiro. Informações de 741 animais foram coletadas de uma fazenda comercial localizada no munícipio de Varzelândia-MG. Os animais eram filhos de 27 touros da raça Nelore e eram categorizados como LA (livro aberto) ou PO (puros de origem). Foram avaliados os dados de peso, ganho de peso médio diário e perímetro escrotal. As avaliações foram realizadas aos 12 (ano) e 18 (sobreano) meses de idade. Os dados foram analisados pelo método dos quadrados mínimos, utilizando um modelo que considerou efeito de categoria (LA ou PO), touro, anos, mês de nascimento e sexo dos bezerros. Houve influência significativa da categoria, sexo, mês de nascimento e touro sobre o desempenho dos animais até o ano, enquanto as características de desempenho ao sobreano foram influenciadas somente pelo mês de nascimento e touro (P<0,05). Sendo assim, os fatores do meio como ano e mês de nascimento e sexo do bezerro são importantes fontes de variação sobre o desempenho dos bezerros do nascimento até o sobreano, devendo, portanto, ser

consideradas na comparação e seleção de animais com base nestas características.

INTRODUCTION

Brazilian beef production is projected to increase strongly in coming decades, with an expectation to grow 2.1% a year from 2016/17 to 2026/27, while beef exports should increase by 3.0% annually (USDA, 2017).

It is estimated that 80% of ruminant animals destined for meat production in Brazil are Zebu and their crosses (ABCZ, 2016). Greatly important for the national livestock system, Nellore breed represents about 80% of these Zebu animals. Therefore, it is essential to maximize their performance because the productivity of the Brazilian herd is still considered low in relation to the other countries. In this sense, the use of genetically improved sires has been an alternative for the livestock sector, since the investment in high quality genetics has a potential return, thus increasing farm income.

Growth traits in the *pre-* and *post-* weaning phases have genetic variability and it can be included in genetic improvement programs because they are responsive to individual selection (SOUZA et al., 2000). Therefore, the live weight becomes an essential tool in the selection process to evaluate the animal's potential to gain weight, helping to choose early maturing cattle.

However, animal-environment interaction is responsible for phenotypic differences and, consequently, animal performance may vary widely. This variation is associated with several factors such as genetic differences between sires and dam, sanitary, reproductive and nutritional management aspects of each region, as well as the sex and the month of birth of the progeny (SOUZA et al., 2000).

To obtain satisfactory results in beef cattle production, it is important to observe that the environmental and management conditions can influence performance traits. Therefore, it is necessary to study offspring productivity considering the environmental conditions and production system adopted. The aim of this study was to evaluate the influence of environmental factors on performance of progeny from different Nellore sires in the Brazilian semiarid region.

MATERIAL AND METHODS

Data were collected in a commercial farm in Varzelândia, MG, located at latitude 15°42'05"S and longitude 44°01'39"W. Varzelandia has a semiarid climate, with high temperatures and precipitation concentrated over a few months, resulting in prolonged drought periods of up to nine months.

Data from 741 Nellore animals were used, of which 388 were classified as OR (open registry) and 353 PB (purebred) animals, born from September 2013 to February 2014, progeny of 27 Nellore sires. Nellore herd book is open to animals (recorded as open registry) who conform to the breed standard by meeting a certain conformation according to the Brazilian Association of Zebu Cattle Breeders, but with no previously registry of their earlier ancestors.

Data on date of birth, pedigree, weaning weight (WW), yearling weight (YW), 18-month weight (18W), yearling scrotal circumference (YSC) and 18-month scrotal circumference (18SC) of male progeny were collected.

Evaluations were taken at 12 (yearling) and 18 months of age. From the total of 741 animals, 672 were evaluated at weaning and 651 were evaluated at 18months, although not all the animals that were measured at the yearling age were assessed at weaning. Therefore, those animals were not considered in the analysis. In addition, 581 animals were evaluated at18months, but for 18SC only 267 animals were assessed. Taken this information above, the average daily gain from birth to weaning (ADGW), average daily gain from birth to yearling age (ADGY) and to 18-month (ADG18) were calculated.

Weaning weight was adjusted to 205 days of age, and ADGW, ADGY and ADG18were obtained by the ratio between the WW, YW and 18W observed, and the estimated birth weight (BW), by the number of days between two observations.

Data on each trait were analyzed using PROC GLM (SAS, 2004) to generate least-squares means, using a model that considers the effect of pedigree (OR or PB), sire, year, month of birth and calf sex. For scrotal circumference traits, the effect of sex was not included in the statistical model.

$$Y_{jklmn} = \mu + G_j + S_k + M_l + A_m + T_n + e_{jklmn}$$

In which:

Y_{jklmn} = Represent the value observed for the trait Y of the n-th animal, of the j-th pedigree; of the k-th sex; born in the m-th year and l-th month, progeny of the n-th sire; μ = overall mean of trait Y; G_j = fixed effect of the j-th pedigree (j = OR and PB); S_k = fixed effect of the k-th sex of the calf (k = 1, male and 2, female); M_l = fixed effect of the l-th month of birth (l = 9,10,11,12,01,02); A_m = fixed effect of the m-th year of birth (m = 2013 and 2014); T_n = fixed effect of n-sire (n = 1,2,3...27); e_{jklmn} = random error associated with each observation.

RESULTS AND DISCUSSION

The mean values observed for WW and ADGW were 208.53 ± 40.17 kg and 0.871 ± 0.196 kg/day, whereas for 18-month a decline in body growth velocity was observed, with the mean weight gain of 0.411 ± 0.063 kg/day (Table 1). These values were similar to those found by other authors (LAUREANO et al., 2011; PANETO et al., 2002; SARMENTO et al., 2003).

Table 1. Number of observations (N), mean, minimum (Min), maximum (Max) and respective standard deviations (SD) for weaning weight[1] (WW), average daily gain at weaning (ADGW), yearling weight[2] (YW), average daily gain up to yearling age (ADGY), 18-month weight[3] (18W), average daily gain up to 18-month (ADG18), yearling (YSC) and 18-month (18SC) scrotal circumference.

Trait	N	Mean	Min	Max	SD
WW, kg	672	208.5	117.0	373.0	40.17
ADGW, kg/day	672	0.871	0.268	1.673	0.196
YW, kg	651	223.3	107.0	392.0	42.31

ADGY, kg/day	651	0.530	0.211	0.992	0.116
18W, kg	581	20.52	16.00	28.00	2.391
ADG18, kg/day	581	256.0	167.0	397.0	35.07
YSC, cm	581	0.411	0.249	0.667	0.063
18SC, cm	267	21.82	16.00	30.00	2.550

[1]Weaning=205 days; [2]Yearling=12 months; [3]18 months.

When studying the growth traits of Nellore cattle, Laureano et al. (2011) observed mean values of 0.74 kg/day and 0.31 kg/day forweight gain from birth to weaning and from weaning to 18months, respectively. The weight gain at different stages of the animal's life can be used as selection criterion, since it is a trait of high heritability and a good indicator of the growth potential of an individual.

There was a significant influence of the pedigree, sex, month of birth and sire on animal's performance until yearling age, whereas the performance traits at 18months were influenced only by the month of birth and sire (P<0.05; Table2). Therefore, all sources of variation included in the model influenced animal performance, evidencing the importance of each one of these factors when comparing and choosing sires.

Table 2. Summary of analysis of variance for weaning weight[1] (WW), average daily gain at weaning (ADGW), yearling weight[2] (YW), average daily gain up to yearling age (ADGY), 18-month weight[3] (18W) and average daily gain up to 18-month (ADG18) of PB (purebred) and OR (open registry) Nellore cattle

		Mean Squares					
SV	**DF**	**WW(kg)**	**ADGW (kg/day)**	**YW(kg)**	**ADGY (kg/day)**	**18W (kg)**	**ADG18 (kg/day)**
PB/OR	1	58968***	1.403***	83275***	0.625***	2199	0.007
Sex	1	40470***	0.962***	251504***	1.887***	2228	0.007
MB	5	29731***	0.707***	51444***	0.385***	51018***	0.168***
Sire	19	3172**	0.075**	1641*	0.012*	1512**	0.004**
R² (%)		28.47	28.48	53.54	53.53	40.40	40.36
CV(%)		16.61	19.40	13.17	15.22	10.82	12.25

*P < 0.05; ** P < 0.01; *** P < 0.0001; [1]Weaning=205 days; [2]Yearling=12 months; [3]18 months.SV= Source of variation; DF= Degrees of freedom; MB= Month of birth; R[2]= coefficient of determination; CV= coefficient of variation.

Regarding the pedigree, PB animals had higher performance up to the yearling age compared to OR offspring (Table 3). The WW of PB animals (223.7 ±

38.26 kg) was 8.76% higher than that of OR progeny (204.1 ± 38.26 kg), leading to a greater performance at the yearling age, with an YW10.55% and ADGY

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12.02% higher than those of OR pedigree, respectively. Ribeiro et al. (2012), when evaluating PB and OR Nellore cattle in feedlot, did not observe differences in weight gain and carcass traits, even though PB animals were considered more genetically selected within-breed. However, according to the same author, these results can be explained due to the similarity in the selection process between these animals. This fact is justified because the Brazilian Association of Zebu Cattle Breeders considers that third-generation crosses of ORxPB cattle are PB animals (RIBEIRO et al, 2012).

Table 3. Number of observations (N), and estimated means forweaning weight[1] (WW), average daily gain at weaning (ADGW), yearling weight[2] (YW), average daily gain up to yearling age (ADGY), 18-month weight[3] (18W), average daily gain up to 18-month (ADG18), yearling (YSC) and 18-month (18SC) scrotal circumference of male (M) or female (F) Nellore PB (purebred) and OR (open registry) cattle

Pedigree	N	WW (kg)	ADGW (kg/day)	YW (kg)	ADGY (kg/day)	18W (kg)	ADG18 (kg/day)	YSC (cm)	18SC (cm)
PB	353	223.7	0.944	239.8	0.574	263.2	0.423	20.72	21.73
OR	388	204.1	0.849	214.5	0.505	253.3	0.405	20.19	21.17
Sex									
F	358	206.3	0.860	207.8	0.487	257.7	0.414	-	-
M	383	221.4	0.933	246.5	0.593	258.7	0.415	-	-

[1]Weaning=205 days; [2]Yearling=12 months; [3]18 months.

When the influence of sex was assessed, males (221.4 ± 38.26 kg) were weaned 15.1 kg heavier than females (206.3 ± 38.26 kg), showing a superiority of 6.77%. Consequently, males had aADGY17.87% higher (0.593 ± 0.11 kg/day) than females (0.487 ± 0.11 kg/day) (Table 3). However, animal performance did not have the same behavior for 18-monthtraits. Other studies also observed a superiority of the males' growth potential over females at weaning (SOUZA et al., 2000, 2004). The high rate of growth of males can be justified due to the increased conversion of androgens into estrogens, stimulating the growth (FERRAZ FILHO et al., 2001; MARTINS et al., 2000).

Regarding the month of birth, it was verified that animals born between the months of September and December had higher performance in relation to animals born in January and February (Table 4).

Table4.Estimated means for weaning weight[1] (WW), average daily gain at weaning(ADGW), yearling weight[2] (YW), average daily gain up to yearling age (ADGY), 18-month weight[3] (18W), average daily gain up to 18-month (ADG18), yearling (YSC) and 18-month (18SC) scrotal circumference of PB (purebred) and OR (open registry) Nellore cattle born in different months

Month/Year of Birth	WW(kg)	ADGW (kg/day)	YW (kg)	ADGY (kg/day)	18W (kg)	ADG18 (kg/day)	YSC (cm)	18SC (cm)
September 2013	288.6	1.261	294.6	0.725	328.9	0.543	23.67	25.00
October 2013	222.6	0.939	243.5	0.585	276.2	0.447	21.56	22.94
November 2013	205.6	0.856	230.0	0.548	264.4	0.426	20.84	21.96
December 2013	205.3	0.855	215.4	0.508	245.6	0.392	19.33	20.77
January 2014	193.2	0.796	197.2	0.458	228.6	0.361	18.75	19.58
February 2014	167.9	0.672	182.1	0.416	205.5	0.319	18.58	18.42

[1]Weaning=205 days; [2]Yearling=12 months; [3]18 months.

Progeny born between September and December had higher WW (230.52 ± 38.26 kg) and ADGW (0.977 ± 0.18 kg/day) in relation to calves born in January and February (WW=183.36 ± 38, 26 kg and ADGW=0.734 kg/day ± 0.18 kg/day), resulting in a noticeable difference in live weight of 119 kg between animals born in September and January. The lighter calves were weaned with 167.9 ± 38.26 kg, were born in February and had values 12.72% lower than those born in September. Alencar et al. (1997) analyzed the performance of calves born from Nellore and Canchim sires and crossbred (F1) Charolais X Nellore and Piedmont x Nellore sires, and they concluded that animals born between June and September were the lightest calves at weaning. Souza et al. (2000), evaluating weaning weights of calves, also concluded that animals born at the end of the dry season are those that perform better. This is justified because of the greater availability of feed to dams in the final third of gestation, favoring the weaning of heavier calves.

Regarding the sire effect, a significant influence was observed for all evaluated traits in the *pre* and *post* weaning phases, as previously mentioned (P<0.05; Table 2). Rosa (2015), evaluating the difference between progeny of commercial sires and genetically improved sires using genetic evaluation data from Embrapa Beef Cattle Breeding Program—Geneplus, found an increase in live weight of 3.9 kg in progeny born from improved sires compared to commercial bulls. Therefore, the use of genetically superior sires brings a great economic return and increases the productivity in beef cattle herds.

In relation to the SC, the observed mean (21.77 ± 2.47 cm) is below the values found for the Nellore breed, ranging from 26.0 to 28.3 cm in animals with the same mean age (BOLIGON et al., 2007; FORNI & ALBUQUERQUE, 2005; LAUREANO et al., 2011). Silva et al. (2002), analyzing the relationship between SC and semen quality of 960 Nellore sires, found an average SC of 25.71 cm for males at 18 months. Lima et al. (2013), studying SC and seminal

characteristics of 24 Nellore sires selected for sexual precocity, observed values of scrotal circumference of 22.37 cm at 12 months, 28.43 cm at 14 months, 29.45 cm at 16 months and 30.77 cm at 18 months. Such variation might be justified because the animals in the present study may have been negatively influenced by low precipitation and low pasture quality in the semiarid region and they were not selected for sexual precocity as in most of the studies cited above, resulting in smaller scrotal circumferences in relation to the literature.

There was significant influence of the month of birth and sire on the YSC and 18SC, but the scrotal circumference was influenced by the OR or PB pedigree only until 12 months of age (P<0.05; Table 5). Animals born between September and November had higher

YSC (22.2 ± 2.37 cm) and 18SC (23.3 cm ± 2.54) than animals born between December and February (YSC = 19.0 ± 2.37 cm and 18SC = 19.6 ± 2.54 cm), a result similar to the performance of progeny evaluated within the same growth phase. The scrotal circumference as well as the *post-weaning* performance may be influenced by environmental factors. Progeny born in September, October and November had higher mean values for 18SC, which may be justified due to the greater performance of animals born at the end of the dry period and beginning of the wet season, as a result of the higher precipitate on levels and feed availability at that time. These results suggest that phenotypic variability in SC expression can also be influenced by environmental conditions.

Table 5. Summary of analysis of variance for yearling scrotal circumference[1] (YSC) and 18-month scrotal circumference[2] (18SC) of PB (purebred) and OR (open registry) Nellore cattle

		Mean Squares	
SV	DF	YSC (cm)	18SC (cm)
PB/OR	1	30.38**	12.38
MB	5	110.6***	105.5***
Sire	19	7.072*	7.935*
R² (%)		38.73	39.98
CV (%)		9.49	9.50

*P < 0.05; ** P < 0.01; *** P < 0.0001; [1]Weaning=205 days; [2]Yearling=12 months; [3]18 months. SV= Source of variation; DF= Degrees of freedom; MB= Month of birth; R^2 = coefficient of determination; CV = coefficient of variation.

It is observed an influence of SC on both weight traits such as WW and 18W, and on reproductive traits such as seminal characteristics. It is known that there is a high correlation between scrotal circumference and the volume of semen produced and both physical and

morphological semen characteristics (DIAS et al., 2008). In the case of females, the SC also influences their reproductive traits, since there is a genetic correlation between age at first calving, calving interval, pregnancy rate and the scrotal circumference of their

ancestor (SIQUEIRA et al., 2013). However, using scrotal circumference as the only selection criterion may not be a good alternative when it is sought to improve the reproductive performance of the herd, since SC may have low genetic correlation with some reproductive traits of females, especially if the SC is measured at younger ages (BOLIGON et al., 2007; PEREIRA et al., 2002).

Growth traits have genetic variability, but they can also be influenced by environmental factors. Therefore, environmental factors such as year, month of birth and calf sex are important sources of variation on the performance of calves from birth to 18monthsand it should be considered when comparing and selecting animals based on these traits.

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