Heterogeneity of variance for lactation persistency and milk yield at 305 days of Gir cows in different environments

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ABSTRACT: The objective of this study was to evaluate the heterogeneity of variance for lactation persistency and milk yield at 305 d (MRA 305) according to different production environments. Records from 38,220 test day milk yield of Gir cows were analyzed. Environments were discriminated in high and low production using k-means clustering. In genetic analysis was used a two-trait random regression model, by Legendre polynomials. Covariance components were obtained by Bayesian inference. To verify the behavior of persistence in different production environments were employed 12 measures (PSi). K-means provided significant differences between environmental groups. Generally, both estimates of heritability and genetic correlation for different measures of persistence and MRA305 showed differences in the two environmental groups. Results showed that in groups of low production, PS2 and PS10 could be considered in genetic evaluations for increased production in the first lactation of Gir cattle.
Keywords: Genetic evaluation; Random regression; Zebu

Introduction

One of the main objectives of dairy cattle breeding programs is to modify lactation curve to diminish the fall of production post-peak, that is to say, the production rates persist at high levels until the closing lactation. Some studies conducted with dairy breeds verify that lactation persistency depend of the environment, i.e., low or high production, showing distinct behavior. According to Gengler (1996) it is clear that an animal with very high production at peak have likely a steeper slope than another that is low producing. Clustering has been used to define homogeneous animal groups within a population or environment, to allow comparison of parameters obtained for a specific trait in a group. Clustering *k-means* is a method for maximizing homogeneity within groups. Therefore, this study aimed to evaluate heterogeneity of variance for lactation persistency and milk yield at 305 d (MRA305) of first lactating Gir cows, in different production environments (low and high).

Materials and Methods

Data were recorded for 4,994 Gir cows, with 10,916 animals in the relationship matrix, from the National Program for Genetic Improvement of Dairy Gir. Data comprised 38,220 records for test day milk yield from the sixth to 305 d of lactation, then distributed in ten monthly classes. Contemporary groups were defined according to the herd, year and month of birth. To differentiate low and high production environments it was used k-means clustering. The mean number was k=2 and initial clusters centers were obtained by distance ordering and observation choice at constant intervals. A two-trait animal model of random regression was used employing the Legendre polynomials. Polynomials of fourth and fifth order were used to model genetic additive and permanent environment effects, respectively. The residual variance was modeled considering heterogeneous structure into six classes (1, 2, 3-4, 5, 6, 7-10).

The obtaining of the components of (co) variance was performed by Bayesian inference using the program GIBBS3F90 (Misztal, 2010). Initially, a chain length of 2,000,000 cycles, with an initial drop of 200,000, and sampling every 50 was established, totalizing 36,000 samples. Variance, heritability and correlations estimates, in each cycle, were obtained from covariance functions. Chain convergence was verified by Heidelberger & Welch (1983) test, from BOA package (Smith, 2007), available in the R program, throughout graphical inspection. For each parameter a period of burn-in was determined, and the minimum initial cycles were 200,000, with subsequent removal of this period proceeding to obtain specific statistics. To check the behavior of the lactation persistency, in both production environments, twelve measures (Table 1) were employed.

Table 1: Representation of the persistence measures used in this study

1	$PS = (Vg_{280} - Vg_{60})$	7	$PS = \left(\frac{1}{51}\sum_{t=255}^{305} Vg_t - \frac{1}{21}\sum_{t=50}^{70} Vg_t\right)$
2	$PS = \left(\sum_{t=106}^{205} Vg_t - \sum_{t=6}^{105} Vg_t\right)$	8	$PS = \left(\sum_{t=61}^{300} Vg_t - (305-60)Vg60\right)$
3	$PS = \left(\sum_{t=206}^{305} Vg_t - \sum_{t=6}^{105} Vg_t\right)$	9	$PS = \left(\sum_{t=101}^{300} Vg_t - (300-100)Vg100\right)$
4	$PS = \sum_{t=61}^{280} (Vg_t - Vg60)$	10	$PS = \sum_{t=31}^{280} (Vg_t - Vg30)$
5	$PS = \sum_{t=60}^{279} (Vg_t - Vg280)$	11	$PS = \sum_{t=31}^{260} (Vg_t - Vg30)$

6	$PS = (Vg_{290} - Vg_{90})$	12	$PS = \left(\frac{1}{201} \sum_{t=60}^{260} Vg_t - \frac{1}{21} \sum_{t=20}^{40} Vg_t \right)$

PS=persistence measures, Vg=breeding value, t= days in milk.

Results and Discussion

From clustering k-means there were two environment groups, low and high production, so there was observed that grouping provided significant environmental differences between them (Hotelling test comparing centroids). The averages are shown in Figure 1. Those results are similar to Vergara et al. (2013) that used the same data and technique of analysis working with test day milk yield using RR models. Generally, both heritability and genetic correlation estimates of persistency with MRA305 were different in the two groups, based on confidence interval of 95% (Table 2).This fact can be attributed to the effect of environment on persistency of lactation. According to Gengler (1990) it is clear that an animal with very high production at peak have likely a steeper slope than another that is low producing. According to Pereira et al., (2013) the heritabilities for persistency, of first lactation Gir cows, were generally lower. Similar estimates have been reported by Pereira et al. (2012) for measures of persistency obtained as functions of milk yields at different stages of lactation of dairy Gir cows.

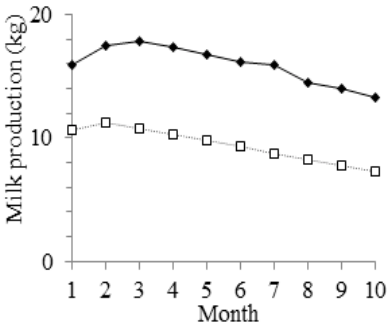

Figure 1: Average lactation curves of the two environment groups, high production level (♦) and low production (□) level, discriminated by k-means method

Table 2: Estimated means (M) and high density intervals for the posterior distributions of the heritability and genetic correlations estimates obtained for lactation persistence (PSi) and 305 d milk production (MRA305) in the high and low production environments

PSi	Heritability					
	High production			Low production		
	Min	M	Max	Min	M	Max
PS1	0.10	0.17	0.24	0.06	0.10	0.14
PS2	0.15	0.29	0.43	0.12	0.18	0.24
PS3	0.17	0.28	0.39	0.11	0.16	0.22
PS4	0.07	0.13	0.20	0.06	0.08	0.12
PS5	0.08	0.14	0.21	0.04	0.07	0.10
PS6	0.09	0.15	0.22	0.06	0.09	0.13
PS7	0.15	0.25	0.35	0.09	0.14	0.20
PS8	0.08	0.14	0.21	0.06	0.09	0.12
PS9	0.06	0.10	0.15	0.06	0.08	0.12
PS10	0.19	0.34	0.49	0.10	0.14	0.19
PS11	0.18	0.33	0.48	0.09	0.14	0.18
PS12	0.05	0.09	0.14	0.06	0.08	0.11
MRA305	0.27	0.38	0.49	0.25	0.31	0.37
PSi	Genetic correlation					
	High production			Low production		
	Min	M	Max	Min	M	Max
PS1	-0.02	0.25	0.47	-0.59	-0.42	-0.24
PS2	0.09	0.37	0.58	-0.18	0.02	0.21
PS3	0.04	0.31	0.52	-0.49	-0.31	-0.12
PS4	0.19	0.45	0.64	-0.41	-0.22	-0.03
PS5	-0.24	0.02	0.29	0.36	0.55	0.72
PS6	-0.14	0.14	0.38	-0.69	-0.53	-0.35
PS7	-0.04	0.24	0.46	-0.58	-0.41	-0.23
PS8	0.14	0.40	0.60	-0.44	-0.26	-0.07
PS9	0.21	0.46	0.65	-0.67	-0.51	-0.34
PS10	-0.01	0.27	0.50	-0.13	0.07	0.26
PS11	-0.01	0.28	0.50	-0.09	0.10	0.29
PS12	0.34	0.57	0.73	-0.59	-0.42	-0.23
MRA305	-	-	-	-	-	-

For the most results, in the high production group, heritability estimates for persistence (PS1-PS11) and MRA305 were moderate, and, in the low production group, the values were low to moderate. The PS9 and PS12 measures presented very similar confidence intervals between the two groups (Table 2), which means that heritabilities were for them. Regarding to genetic correlations PSI (Table 2) and MRA305, in the high production group, values were generally positive; and, in the low production group, it was observed most moderate negative values, except for the PS2, PS5 and PS10 measures, which were positive. In the last group, PS2 and PS10 showed moderate heritability and genetic correlation close to zero, meaning that these measures of persistency could be considered in genetic evaluations. Likewise, in high production group, correlations between persistency and accumulated 305 d yield were positive and small in magnitude, getting higher in the final third of lactation in Gir cows (Pereira et al., 2012). The results show the need to consider differences in behavior of those traits, according to the production level, in genetic analyzes to obtain accurate estimates of the parameters.

Conclusion

The results using k-means clustering highlighted differences in heritability and genetic correlations of persistency measures with MRA305 in two environmental groups (low and high production). In the low production group, is recommended to use PS2 and PS10 as desired traits in genetic evaluations to obtain more accurate estimates and positive results for increased production in the first lactation of Gir cattle.

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