Bulgarian Journal of Agricultural Science, 24 (Suppl. 2) 2018,
Agricultural Academy

SOURCES OF SPECIFIC VARIANCE AND HERITABILITY OF FREE JUMP QUALITIES IN 2-YEARS OLD HORSES FROM THE EAST BULGARIAN BREED

ILIYANA SABEVA[1]*; MAYA POPOVA[2]; SVETLOZAR KASTCHIEV[3†]
[1] *Agricultural Institute – Shumen*
[2] *Agrarian University, Plovdiv*
[3] *DP Kabiuk, Shumen*

Abstract

Sabeva, I., M. Popova, Sv. Kastchiev †,2018. Sources of specific variance and heritability of free jump qualities in 2-years old horses from the East Bulgarian breed. Bulg. J. Agric. Sci., 24 (Suppl. 2): 85-89

The influence of different sources of variability on the phenotypic variance of free jump qualities, the rate of the additive variance and the correlative relationships with traits characterizing movement have been studied. The study was carried out on the basis of data from the complex assessment by its own productivity of 191 East Bulgarian horses at the age of 2 years old, tested during the period of 2006-2016. Performance tests for 2 years old horses have been conducted in two consecutive days with pre-adaptive period for one week. No preliminary selection has been applied for the participants. There was a relatively constant structure of judging committee. Qualities of free jump (without rider) and allures were evaluated with a 10-score system with accuracy to 0.5. Registration of animals and traits was made by Association East Bulgarian Horse. Analyses of variance, estimations of different sources of variability, heritability and correlations were made by mixed model methodology.

Family belonging of horses, lineal belonging of dams and sex were statistically proven sources of phenotypic variance. The progeny of mares from Ohota, Likuiushta and Longuza families, and those originated from world famous in sport horse lines of Devis Own (through stallions Da Kapo and Don Primero), Ramzes (through Raskalino), Alme Z (through Kuidams Rubin) and Ladykiller (through Limnos) was characterized with very good jumping abilities.

Favorable genetic correlations were established between qualities of free jump and: correctness (0.59); overall gaits (0.39); qualities of free gallop (0.35). Phenotypic and genetic correlations between qualities of free jump and evaluation of walk and trot were low. There were moderate values of free jump heritability.

Key words: free jump, heritability, correlation, performance test, 2-years old sport horse.

**Corresponding author*: iliana_sabeva@abv.bg

Introduction

East Bulgarian horse breed is a small population with limited genetic pool. During the last two generation intervals the purpose of the selection was to improve jumping abilities. The assessment of heredity determined variance was important for establishing the breeding goals and methods for their achievement. According to Koenen & Aldridge (2002) in Germany and Netherlands genetic analyses were based on data from station performance tests and competitions; in Denmark and Sweden – on station performance tests; and in Belgium, France and Ireland – only on competitions. In Bulgaria short-term breeding tests have been carried out since 2006.

In a study on the results of stallions' performance test Olsson et al. (2000) have established average to high heredity determination of free jump (0.47±0.13), high repeatability of trait (0.58) and high genetic correlation with the results of assessment under rider. According to Olsson et al. (2000), Viklund et al. (2008), Posta et al. (2010b) and etc. there were some favorable genetic correlations ranged from 0.26 to 0.70 between assessments of gallop and jump. Evaluation of heritability of free jump in Oldenburg mares varied from 0.541 to 0.564 depending on their age at the time of test (Becker et al., 2011). Investigations of Hanni Luehrs-Behnke (2002) based on mares' performance tests made of all German Warmblood horses indicated lower heritability – 0.32. Posta et al. (2010a) have established heritability from 0.39 to 0.49 and high genetic correlations between assessments of free jump, walk, trot and gallop without a rider in mares from Hungarian sport horse. There are low and rarely moderate values of the additive variance of traits characterizing jumping abilities of different ages in disciplines of equestrian sport (Koenen et al. 1995, Ricard & Chanu 2000, Posta et al. 2010, Prochniak et al. 2015, Rovere et al. 2015, etc.). Summarizing the results from 17 scientific works Thoren et al. (2006) concluded that analyses from tests' data of younger horses and younger stallions indicated higher heritability values and higher genetic correlations with the successive sport results.

The first complex assessment by its own productivity of East Bulgarian horses was made at the age of 2 years old and the weight of free jump assessment is 20% from the complex one. That's why we made the present study to investigate the influence of different sources of variability on the phenotypic variance of free jump qualities, the value of the additive variance and the correlative relationships with traits characterizing movement qualities.

Material and Methods

The study was worked out on the basis of data from the complex assessment by its own productivity of 191 East Bulgarian horses at the age of 2 years old, tested during the period of 2006-2016. Performance tests for 2 years old horses have been conducted in two consecutive days with pre-adaptive period for one week. No preliminary selection has been applied for the participants. There was a relatively constant structure of judging committee. Qualities of free jump (without rider) and allures were evaluated with a 10-score system with accuracy to 0.5. Registration of animals and traits was made by Association East Bulgarian Horse.

Analyses of variance, estimations of different sources of variability, heritability and correlations were made by mixed model methodology. It was established with preliminary studies that factors year of test and month of birth of horses didn't influence significantly on the phenotypic variability. The structure of the used operational model had the following linear expression:

$$Y_{ijksnlop}=\mu+S*L_i+F_j+LM_k+YB_s+G_n+e_{ijksnlop}$$

where: $Y_{ijklmop}$ – observation vector; μ- population average; $S*L_i$, F_j, LM_k, YB_s and G_n, are: random effect of interaction sire*line (i=37) and: fixed effects of family (j=16); dam's line (κ=21); birth year (s=14); sex (n=2); $e_{ijksnlop}$ – residual variance.

The value of the additive variance was calculated through the sire's half-sib analyses including effects of linear belonging of horses, years of birth and sex. Without having any essential differences of the phenotypic variation, MINQUE estimation of the additive component of variance increased when the size of offspring groups grew bigger (more than 2, more than 3 and more than 5) and the correlations between classes decreased. The above mentioned statements were based on the information from preliminary investigations on the parameters of the used data files.

Results and Discussion

Judges estimated the qualities of jump through the basic criteria technique, strength and natural ability to map out the distance before and after the jump. Scores of free jump were from 5.40 to 8.83 score, average 6.79 at the standard deviation from 0.50 and coefficient of variation from 7.43%. The results from the analyses of variance for jump and correctness (without a rider) only are presented in Table 1, because of the favorable genetic correlations between correctness of movement and trot, free gallop and totally for gaits determined in our previous study (Popova and Sabeva, 2017).

The influence of family belonging of horses, lineal belonging of dams and sex were statistically proved in both of the given traits. Differences between sexes of free jump were in favor of males (BLUE = + 0. 012). At two years of age colts are often more athletic than fillies and showed better strength potentialities.

East Bulgarian horse was acknowledged as a breed in 1951 on the basis of formed 16 genealogical lines and more than 27 families. In addition to pure breeding, a grading with thoroughbreds and stallions from the recognized sport warmblood breeds has been periodically carried out. At the present stage of breed development, the breeding work was carried out with 15 family nests differing by degree of expression of certain exterior, constitutional and productive characteristics. The families of Ohota, Likuiushta and Longuza possessed productivity over the average for the population regarding the qualities of the free jump, having in mind the bulk of the progeny groups, (table 2).

During the last three generation intervals the selection was oriented towards changing the constitutionally-productive type - from racing to suitable one for the equestrian sport disciplines. Results from the present and earlier studies (Sabeva, 1990) indicated that the improvement of jumping abilities was the slowest for the families of Nerazdelna, Kilia and Leila which representatives have surpassed their coevals in regards to their racing time. The achievements of horses from Krastanka and Vodka families were poorer in the racing disciplines and surpassed significantly the average of the free jumping qualities. Mares from Ohota, Nagaika, Malta, Longuza, Likuyushta and Slavyanka families had wide genealogical matched couples and their progeny surpassed all the others in both productive directions.

Progeny of dams belonging to old lines of Tihany, Zenger, Vustershire and Edelknabe got negative constants (table 2). Progeny of mares originated from thoroughtbreeds Makar, Grapholog, Dracedion, and Galego showed productivity above the average for the population. Grapholog, Dracedion, and Galego are representatives of the Tedy line, and Makar – of Bayardo through branching of Gey Krusader. Mares originating from world famous in equestrian sport lines of Devis Own (through stallions Da Kapo and Don Primero), Ramzes (through Raskalino) Alme Z (through Kuidams Rubin) and Ladykiller (through Limnos) gave birth of horses with better jumping abilities. The positive effect of these lines varied in the range of 0.08 to 1.33 scores.

Favorable genetic correlations were established between qualities of free jump and: correctness (0.59); overall gaits (0.39); qualities of free gallop (0.35). There were lower phenotypic and genetic correlations between qualities of free jump and estimations of walk and trot (table 3). The value of heredity determined variance was 0.43 in model without interactions and 0.55 in model with nested effects of sires in lines. Effects of genealogical groups in long term selected breed with formed structure are result from different interlineal and lineal-family crosses and their use as nested effects may lead to overestimation or underestimation of the heritability. In this case the use of nested effect caused 12% calculative difference. The range of such differences provides useful information to breeders, especially when there are low and moderate values of phenotypic and genetic correlations, and the differences between them for the same trait are not big (Table 3). Due to the small set of data and low threshold of the offspring groups (2-29 animals), the value of the additive variance may be considered as overestimated. However, it can be assumed that the inheritance of the free jump in East Bulgarian breed is within the range of moderate values.

Table 1. Anova

Sources of variability	df	Free jump F- test	Correctness F- test
Sire*line	37	random	random
Family	15	+	+
Dam's line	20	+	+
Year of birth	13	n.s.	n.s.
Sex	1	+	+
R^2 of model		0.50	0.51

Table 3. Heritability, phenotypic and genetic correlations

Traits	Free jump $h^2 = 0.43$	
	Rp	Rg
Gaits overall	0.37	0.39
Walk	0.21	0.29
Trot	0.18	0.21
Free gallop	0.32	0.35
Correctness	0.51	0.59

Table 2. Effect of genealogical groups

Family	n	Free jump		Dam's line	n	Free jump	
		BLUE ± SE	BLUE-constsnt			BLUE ± SE	BLUE-constsnt
Krastanka	2	7.22 ± 0.43	0.31	Tihany	14	6.65 ± 0.18	-0.26
Hana	8	6.41 ± 0.22	-0.50	Zenger	11	6.45 ± 0.20	-0,45
Hodeida	4	6.55 ± 0.29	-0.36	Vustershire	33	6.73 ± 0.13	-0.17
Kilia	5	6.80 ± 0.26	-0.25	Edelknabe	2	6.18 ± 0.41	-0.73
Longuza	10	6.94 ± 0.22	0.03	With origin from purebred			
Slavyanka	5	6.93 ± 0.28	0.02	Makar	7	7.05 ± 0.23	0.13
Likuiushta	17	6.97 ± 0.15	0.06	Kajus	9	6.66 ± 0.21	-0.25
Leila	22	6.82 ± 0.15	-0.09	Grapholog	4	7.04 ± 0.29	0.13
Nerazdelna	13	6.58 ± 0.17	-0.33	Dracedion	2	7.14 ± 0.40	0.23
Ohota	27	7.09 ± 0.15	0.18	Giacint	5	6.53 ± 0.27	-0.37
Genoveva	3	6.91 ± 0.36	-0.01	Galego	6	7.27 ± 0.24	0.36
Malta	3	7.05 ± 0.33	0.14	Other	11	6.63 ± 0.20	-0.27
Nagaika	3	8.51 ± 0.34	1.59	With origin from			
Vodka	3	7.02 ± 0.39	0.11	Devis Own	20	7.17 ± 0.15	0.26
others	66	6.72 ± 0.10	-0.19	Dampfross	15	6.90 ± 0.17	-0.01
μ ± SE	191	6.91±0.10		Adeptus XX	21	6.87 ± 0.16	-0.04
				Ramzes	4	7.02 ± 0.29	0.11
				Alme Z	2	8.24 ± 0.58	1.33
				Cor de la Bry-ere	4	6.61 ± 0.30	-0.30
				Ladykiller	4	6.99 ± 0.34	0.08
				Gagne Si Pen	7	6.54 ± 0.25	-0.36
				Tempelhuter	2	7.22 ± 0.55	0.31
				others	8	7.20 ± 0.19	0.29
μ ± SE	191	6.91±0.10			191	6.91±0.10	

Conclusions

Family belonging of horses, lineal belonging of dams and sex were statistically proven sources of phenotypic variance. The progeny of mares from Ohota, Likuiushta and Longuza families, and those originated from world famous in sport horse lines of Devis Own (through stallions Da Kapo and Don Primero), Ramzes (through Raskalino), Alme Z (through Kuidams Rubin) and Ladykiller (through Limnos) was characterized with very good jumping abilities.

Favorable genetic correlations were established between qualities of free jump and correctness, qualities of free jump and overall gaits, qualities of free jump and qualities of free gallop. Phenotypic and genetic correlations between qualities of free jump and evaluation of walk and trot were low value. There were moderate values of free jump heritability.

Aknowledgements

The publishing of the present scientific paper is co-financed by "Scientific Researches" Fund Contract №01/31 from 17.08.2017.

References

Becker, A.C., K.F. Stock, O. Distl, 2011. Genetic correlations between free movement and movement under rider in performance tests of German Warmblood Horses. *Livestock Science*, **142**: 245-252.

Hanni Luehrs-Behnke, R. Roehe, E. Calm, 2002. Genetic association among traits of the new integrated breeding evaluation method used for selection of German Warmblood horses. *Veterinarija ir Zootechnika*, **18**(40): 90-93.

Helsten, E. Thoren, A. Viklund, E.P.C. Koenen, A. Ricard, E. Bruns, J. Philipsson, 2006. Review of genetic parameters estimated at stallion and young horse performance tests and their correlations with later results in dressage and show-jumping competition. *Livestock Science*, **103**(1-2):1-12.

Koenen, E.P.C, L.I. Aldridge, 2002. Testing and genetic evaluation of sport horses in an international perspective. 7-th World Congress Applied to Livestock Production, Montpellier, 5 p.

Koenen, E.P.C, A.E. van Veldhuizen, E.W. Brascamp, 1995. Genetic parameters of linear scored conformation traits and their relation to dressage and show-jumping performance in the Dutch Warmblood Riding Horse population. *Livestock Production Science*, **43**: 85-94.

Olsson, E., Th. Arnason, Anna Nashholm, J. Philipsson, 2000. Genetic parameters for traits at performance test of stallions and correlation with traits at progeny test in Swedish warmblood horses. *Livestock Production Scienc*e, **65**: 81-89.

Popova, M., I. Sabeva, 2017. Sources of specific variance and genetic parameters of gaits quality in 2-wears old horses from East Bulgarian Breed. *Journal of Central European Agriculture* /by press/.

Posta, J., I. Komlosi, S. Mihok, 2010a. Genetic parameters of Hungarian Sport Horse. Mare performance tests. *Animal Science Papers and Reports*, **28**(4): 373-380.

Posta, J., I. Komlosi, S. Mihok, 2010b. Random regression model estimation of genetic parameters for show-jumping results of Hungarian Sport Horse. *J. Anim. Breed Genet.*, **127**(4): 280-288.

Prochniak, T., I. Rozempolska-Rucinska, G. Zieba, M. Lukaszewicz. 2015. Genetic variability of show jumping attributes in young horses commencing competing. *Asian-Australas J. Anim. Sci.*, **28**(8): 1090-1094.

Ricard, A., I. Chanu, 2001. Genetic parameters of eventing horse competitions in France. *Genet. Sel. Evol.,* **33**: 175-190.

Rovere, G., P. Madsen, E. Norberg, J.A.M. van Arendonk, B.J. Ducro, 2015. Effect of specialization on genetic parameters of studbook-entry inspection in Dutch Warmblood horses. *Journal of Animal Breeding and Genetic*, **133**(4): 283-290.

Sabeva I., 1990. Effect of family belonging of horses of East Bulgarian breed on racing time. Journal of animal science, vol. XXVII, № 2:71-75(BG). (Effect of family belonging of horses of East Bulgarian breed on racing time. Animal Science, vol. XXVII, № 2:71-75)

Thoren Hellsten E., A. Vakund, EPC Koenen, A.Ricard, E. Bruns, J. Philipsson, 2006. Review of genetic parameters estimated at stallion and young horse performance tests and their correlations with later results in dressage and show-jumping competitions. *Livestock Science*, **103**: 1-12.