

## **EFFECT OF THE LINEAL AND FAMILY BELONGING OF BROODMARES FROM THE SHAGYA BREED WITH RESPECT TO THE HEIGHT AT WITHERS AND CANNON GIRTH**

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### **Abstract**

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The height at withers and the cannon girth of 247 Shagya horses born by broodmares, acted during the last two generation intervals at the Kabiuk Stud, were investigated. The variance analysis, the estimations of different sources of variability and the correlations between the traits at different ages were done by the mixed models methodology.

It was established that the interactions between the lineal and family belonging of the brood mares were a significant source of specific variance with respect to the traits – height at withers and cannon girth. The genetic superiority of horses born from the combinations between Kuhailan Zaid and Oborona, Kuhailan Zaid and Mazkur I was the highest, and with respect to the cannon girth – between Kuhailan Zaid and Oborona, Kuhailan Zaid and Sheraky 1-9, Kuhailan Zaid and Celina, and Shagya and Nadezhda II.

The phenotypic and genetic correlations between: the height at withers at one and two years of age; the height at withers at two and three years of age; the height at withers at one year of age and the cannon girth at two years of age; and between the cannon girth at two and three years of age had high values. The correlations between the height at withers at one and three years of age and between the height at withers at one year of age and the cannon girth at three years of age were low.

*Key words:* horse-breeding, genealogical groups, interactions, genetic parameters

### **Introduction**

The improvement of valuable economic traits in horse breeds with a built up structure is realized by applying different systems of individual mating within the existing genealogical complexes (Hitenkov, 1971; Pern, 1978; Karaivanov et al., 1984). The effectiveness of mating directly depends on the value of the differentiated lineal and family additive variance

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throughout many generations. Detecting the best combinations between lines and families facilitates the discovery of successful individual crosses, on which the realized genetic progress in the populations largely depends. In the past Karaivanov and Dobrev (1968, 1984) conducted studies on the combination between the qualities of lines and families from the Arabian breed. The authors analyzed the number of mares who were left for breeding from crosses between different

lines and families.

The Shagya horses raised in Bulgaria have well expressed typicality and tend to the lighter type of the breed. Their body development is very close to the body development of the Purebred Arabian horse. In compliance with regulation issued by ISG<sub>/2007/</sub> stallions which are subject to licensing should have height at withers at least 154 cm. The purpose is by indirect selection to improve the jumping abilities (Hintz 1980, Koenen et al., 1995). The requirement of minimal threshold with respect to the height at withers makes the increase in height in horses a priority of selection in the population raised in Bulgaria.

The objective of this study was to investigate the interaction between the lineal and family belonging of broodmares from the Shagya breed with respect to the height at withers and cannon girth of their progeny.

## Material and Methods

Subject of study were the traits – height at withers and cannon girth of 247 Shagya horses born by broodmares acted during the last two generation intervals at the Kabiuk Stud.

The variance analysis, the estimations of different sources of variability and the correlations between the traits at different ages were done by the mixed models methodology.

The structure of the operational model had the following linear expression:

$$Y_{ikln} = \mu + A_i + B_j + C_k + D_l + e_{ikln}$$

Where:  $\mu$  is the mean;  $A_i$  – random effect of the  $i^{\text{th}}$  sire ( $i = 1 \dots 17$ );  $B_j$  – fixed effect of the  $j^{\text{th}}$  interaction between the lineal and family belonging of broodmares ( $j = 1 \dots 32$ );  $C_k$  – fixed effect of the  $k^{\text{th}}$  sex ( $k = 1-2$ );  $D_l$  – fixed effect of the  $l^{\text{th}}$  year of birth ( $l = 1 \dots 19$ );  $e_{ikln}$  – random error of the  $n^{\text{th}}$  observation ( $n = 1 \dots 247$ );

The Henderson's mixed model equations were used for calculation the best unbiased estimations of the network of fixed effects (Harvey, 1990).

## Results and Discussion

The first selection by type, body measurements and exterior in the larger stud herds is often carried out when horses reach one year of age, although their economic maturity occurs considerably later. The average height at withers of the one-year-old horses was  $140 \pm 3.42$  cm and the cannon girth -  $17.54 \pm 0.62$  cm (Table 1). The variation coefficients were 2.44 % and 3.58% respectively. The interaction between the lineal and family belonging of dams, sex and year of birth were sources of specific variance with different degree of probability with respect to the traits studied. During the investigated period the male horses exceeded the female ones with respect to the height at withers by 1.10 cm, and with respect to the cannon girth - by 0.65 cm. The differences between the sires were significant only with respect to the height at withers at three years of age.

**Table 1**  
Analysis of variance of the traits studied

Sources of variations	df	Height at withers		Cannon girth	
		At one year	At one year	At one year	At one year
		F - test	F - test	F - test	F - test
Sire	17	n,s,	+	n,s,	n,s,
Dam's line *family	32	+	+	++	+
Sex	1	+++	++	+++	+++
Year of birth	19	+++	+	++	n,s,
R		0.53	0.53	0.58	0.72
x ± s.d.		140.56 ± 3.42	151.62 ± 1.67	17.54 ± 0.62	18.80 ± 0.46
CV		2.44	1.67	3.58	2.5

\* + P < 0,05, ++ P < 0,01, +++ P < 0,001, n.s. – non significant,

**Table 2**  
**Effect of the interaction between the lineal and family belonging of the broodmares with respect to the height at withers and cannon girth at one year of age and their progeny**

Dam's line * family	n	Height at withers		Cannon girth	n	Height at withers		Cannon girth
		BLUE	BLUE			BLUE	BLUE	
Pamuk * Nadezhda II	10	2.41	0.24	0.24	6	-0.35	-0.27	-0.2
Pamuk * Matzkour I	11	0.11	0.18	0.18	2	2.99	-0.53	-0.08
Pamuk * Celina	21	0.74	0.26	0.26	4	-4.55	-0.26	-0.79
Pamuk * Oborona	3	0.11	0.47	0.47	11	-1.03	-1.15	0.01
Pamuk * broodmares with no family belonging	6	2.54	0.22	0.22	9	-2.55	-0.27	-0.27
Kuhailan Zaid * Matzkour I	11	0.3	0.06	0.06	9	-3.93	-0.53	-0.53
Kuhailan Zaid * Celina	5	1.22	0.43	0.43	6	0.29	-0.26	-0.26
Kuhailan Zaid * Oborona	4	4.92	0.89	0.89	3	-5.71	-1.15	-1.15
Kuhailan Zaid * broodmares with no family belonging	6	-0.93	0.02	0.02	11	-1.83	-0.1	-0.1
Shagya XI * broodmares with no family belonging	3	2.71	0.53	0.53	14	-0.74	-0.24	-0.24
Shagya XI * Nadezhda II	4	2.39	0.44	0.44	5	-0.75	0.01	0.01
Shagya XI * Matzkour I	3	-0.72	-40	-40	8	1.75	0.19	0.19
Shagya XI * Celina	3	-1.32	-0.14	-0.14	7	-4.46	-0.68	-0.68
Shagya XI * Oborona	4	3.68	1	1	6	-1	-0.03	-0.03
Bebe * Nadezhda II	10	1.63	0.11	0.11	6	-1.32	-0.38	-0.38
Bebe * Emiretschka	14	1.42	0.17	0.17	6	1.45	0.18	0.18

**Table 3**  
**Effect of the interaction between the lineal and family belonging of the broodmares with respect to the height at withers and cannon girth at three years of age and their progeny**

Dam's line * family	n	Height at withers		n	Dam's line * family		n	Height at withers		Cannon girth
		BLUE	BLUE		BLUE	BLUE		BLUE	BLUE	
Pamuk * Nadezhda II	10	1.79	0.15	6	Siglavý Bagdady * Celina	6	-1.88	-0.01		
Pamuk * Matzkour I	11	0.63	0.03	2	Skowronek * Nadezhda II	2	1.83	0.12		
Pamuk * Celina	21	0.21	0.18	4	Skowronek * Emiretschka	4	-0.81	-0.64		
Pamuk * Oborona	3	-1.27	0.28	11	Skowronek * Маукуп I	11	-0.57	-0.12		
Pamuk * broodmares with no family belonging	6	-0.9	0.04	9	Skowronek * Celina	9	-1.82	-0.1		
Kuhailan Zaid * Matzkour I	11	2.85	0.21	9	Skowronek * Sheraky 1-9	9	-0.97	-0.23		
Kuhailan Zaid * Celina	5	1.25	0.43	6	Skowronek * Oborona	6	0.52	0.11		
Kuhailan Zaid * Oborona	4	3.3	0.48	3	Kuhailan Afas * Emiretschka	3	-3.6	-0.89		
Kuhailan Zaid * broodmares with no family belonging	6	-3.2	-0.01	11	Kuhailan Afas * Matzkour I	11	-0.44	-0.57		
Shagya XI * broodmares with no family belonging	3	0.48	0.2	14	Kuhailan Afas * Celina	14	-0.1	-0.09		
Shagya XI * Nadezhda II	4	0.97	0.38	5	Kuhailan Afas * Sheraky 1-9	5	-0.12	0.45		
Shagya XI * Matzkour I	3	-1.04	0.01	8	Kontur * Sheraky 1-9	8	1.13	-0.02		
Shagya XI * Celina	3	0.23	-0.16	7	Mansour * Nadezhda II	7	-1.98	-0.73		
Shagya XI * Oborona	4	2.02	0.73	6	Mansour * Matzkour I	6	-1.12	-0.04		
Bebe * Nadezhda II	10	0.8	-0.26	6	Mansour * Celina	6	2.17	0.2		
Bebe * Emiretschka	14	0.18	0.09	6	Kuhailan Haif * Celina	6	-0.19	0.01		

During the investigated period 20.64% of the horses originated from dams belonging to the line of Pamuk, 16.60% – to the line of Skowronek, 13.36% – to the line of Kuhailan Afas 10.53% – to the line of Kuhailan Zaid, 9.72% – to the line of Bebe, 7.69% – to the line of Saklawi I (Mansour), 5.26% – to the line of Shagya and 16.20% – to other lines. The estimations of the line\*family crosses from which the broodmares originate are given in Table 2. With a few exceptions the effects of the particular interactions with respect to the height at withers and cannon girth were unidirectional. The unidirectionality of the estimations means that the horses from the studied population had well developed bone system, proportional to the height. The following crosses received positive BLUE-constants: the line of Pamuk with the families of Nadezhda II, Matzkour I, Celina and Oborona; the line of Kuhailan Zaid with the families of Matzkour I, Celina and Oborona; the line of Bebe with the families of Nadezhda II and Emiretschka; the line of

Skowronek with the families of Nadezhda II and Oborona; the line of Kontur with the families of Sheraky 1-9; the line of Shagya with the families of Nadezhda II and Oborona; and the line of Kuhailan Haifi with the family of Celina. Most of the estimations of the line\*family interactions of the lines of Skowronek, Kuhailan Afas and Mansour were negative as mainly Purebred Arabian stallions from those lines were used.

The proportion of horses depending on the family belonging was as follows: 25.5% of the offspring were from the family of Celina, 21.46% – from the family of Matzkour I, 13.36% – from Nadezhda II, 6.88% – from Oborona, and others with less relative part. Estimations over the mean were found for 82.35% of the interactions with the family of Oborona, 78.79% – with the family of Nadezhda II, 60.62% – with the family of Celina and 41.51% – with the family of Matzkour I. These results show that the mares from the mentioned families found wide genealogical com-

**Table 4**

**Phenotypic and genetic correlations between the traits studied at different ages**

Traits	$r_p$	$r_g$
Height at withers at one year of age – Height at withers at two years of age	0.52	0.54
Height at withers at one year of age – Height at withers at three years of age	0.38	0.25
Height at withers at two years of age – Height at withers at three years of age	0.59	0.69
Height at withers at one year of age – Cannon girth at one year of age	0.64	0.23
Height at withers at one year of age – Cannon girth at two years of age	0.35	0.63
Height at withers at one year of age – Cannon girth at three years of age	0.38	0.25
Cannon girth at one year of age – Cannon girth at two years of age	0.66	0.2
Cannon girth at one year of age – Cannon girth at three years of age	0.47	0.02
Cannon girth at two years of age – Cannon girth at three years of age	0.62	0.78





bination with respect to the traits studied (Table 2).

The effects of the lineal and family interactions at three years of age in most cases did not considerably differ from the effects established at one year of age (Table 3). The constants for the height at withers changed from positive into negative for the combinations: Pamuk – Oborona, Kuhailan Haifi – Celina, and for the cannon girth – Bebe – Nadezhda II, and Kontur – Sheraky 1-9. Dams from the combinations Shagya – Celina for the height at withers and Skowronek – Oborona for the cannon girth gave birth to late mature horses, since the estimations of these interactions were negative at one year of age and positive at three years of age. With respect to the height at withers the highest genetic superiority belonged to the combinations Kuhailan Zaid – Oborona (+ 3.30 cm), Kuhailan Zaid – Matzkour I (+ 2.85 cm), Shagya – Oborona (+ 2.02 cm) and Skowronek – Nadezhda II (+ 1.83 cm), and with respect to cannon girth – Kuhailan Zaid – Oborona (+ 0.48 cm), Kuhailan Afas – Sheraky 1-9 (+ 0.45 cm), Kuhailan Zaid – Celina (+ 0.43 cm) and Shagya – Nadezhda II (+ 0.38 cm).

The phenotypic and genetic correlations between the traits studied at different ages are given in Table 4. The phenotypic and genetic correlations between: the height at withers at the one and two years of age; the height at withers at two and three years of age; the height at withers at one year of age and the cannon girth at two years of age; and between the cannon girth at two and three years of age had high values. The correlations between the height at withers at one and three years of age and between the height at withers at one year of age and the cannon girth at three years of age were low. The data shows that conducting selection before two years of age would lead to inaccurate estimation of the animals' breeding value, and consequently to elimination of valuable interactive lineal and family combinations giving late mature offspring.

## Conclusions

The interactions between the lineal and family be-

longing of the broodmares were a significant source of specific variance with respect to the traits – height at withers and cannon girth. The genetic superiority of horses born from the combinations between Kuhailan Zaid and Oborona, Kuhailan Zaid and Matzkour I, Shagya and Oborona, and Skowronek and Nadezhda II was the highest, and with respect to the cannon girth – between Kuhailan Zaid and Oborona, Kuhailan Afas and Sheraky 1-9, Kuhailan Zaid and Celina, and Shagya and Nadezhda II.

Low correlations were established between the height at withers at one and three years of age and between the height at withers at one year of age and the cannon girth at three years of age.

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