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EFFECT OF SOME FACTORS ON THE BIOLOGICAL PROLIFICACY OF SHEEP FROM THE NORTH-EAST BULGARIAN MERINO BREED

Genoveva STAYKOVA[1], Margarit ILIEV[2], Todor TSONEV[3]

[1]Agricultural Institute - Shumen, 3 Simeon Veliki Blvd, 9700 Shumen,
Agricultural Academy of Bulgaria, 1373, Sofia, Bulgaria
[2]Institute of Agriculture - Karnobat, 1 Industrialna Street, 8400, Karnobat,
Agricultural Academy of Bulgaria, 1373, Sofia, Bulgaria
[3]Research Center for Agriculture - Targovishte, 91 Kyustendzha Street, 7700, Targovishte,
Agricultural Academy of Bulgaria, 1373, Sofia, Bulgaria

Corresponding author email: staikova666@abv.bg

Abstract

The subject of the study were 617 sheep from the Northeast Bulgarian Fine-Fleece Sheep Breed (NBFF) - Shumen inter-breed type, born from 2013 to 2018 and bred in the Scientific Center for Agriculture - Targovishte. The biological prolificacy trait at different ages has been investigated. There were 1839 observations of biological prolificacy from the first to the fifth lambing. The influence of the factors - breeding line, type of mating and year of birth was researched. The variance was analyzed on the basis of a multifactorial linear statistical model for each study age (consecutive lambing). The linear affiliation has a significant effect on biological prolificacy up to the third lambing. The type of mating has a significant effect on biological prolificacy at first lambing only. Sheep from the line No. 61 with FecB gene from Booroola Merino are superior in prolificacy the purebred and the lines with Australian Merino genes up to 4.5 years. The biological prolificacy increaseed by the second lambing and was highest at 3.5 years (117%).

Key words: *breeding line, Northeast Bulgarian Fine-Fleece Breed (NEFF), prolificacy, sheep, type of mating, year of birth.*

INTRODUCTION

Biological prolificacy largely determines the profitability of production in the modern sheep farm. Meat is one of the main products, forming 50-60% of the total income in the dairy sector in our country (Stancheva & Staykova, 2009), from 52.13% to 69.34% in the aboriginal breeds (Staykova, 2005) and over 70% in the meat and fine fleece sheep farming (Boykovski et al., 2006). Our authors investigated the heritable variance of prolificacy in sheep and proved that it is low and the expected efficiency of mass selection on this trait is insignificant (Boykovski et al., 2002; 2009; Slavov et al., 2008; Stancheva et al., 2005; Stancheva, 2013). Through genetic improvement, good results have been obtained in a much shorter time. The Australian Booroola Merino (BoM) is a valuable genetic resource for increasing biological prolificacy in fine fleece and other sheep breeds worldwide. The effect of the introduction of the F gene (FecB) from the Booroola Merino breed for high prolificacy in sheep has been studied by a number of authors over a period of about 40 years (Turner, 1978; Bindon, 1984; Davis & Hinch, 1987; Davis et al., 1998; Fogarty, 2009; Abraham & Thomas, 2012). Tsonev (2014), Boykovski et al. (2018) and Slavova (2019) comment on the levels of the main productive traits in Bulgarian fine fleece breeds and their crosses with Booroola Merino.

Frozen seminal fluid from two Booroola Merino rams was imported into Bulgaria in 1988, evaluated for progeny at the Haldon station - New Zealand. As a result of introduction of the F-gene from Booroola Merino into the genetic structure of the flock of North-Eastern Bulgarian Fine Fleece Breed (NBFF) sheep at Scientific Centre for Agriculture - Targovishte, two breeding lines were formed, originating from the homozygous for this gene rams No. 61 and No. 377, of which only the first is currently active. Slavov et al. (2008) found an increase in genetic variance when including genetic components from the Booroola Merino, Australian Merino and Ile de France breeds in the NBFF-Dobrudzhan type population. Laleva et al. (2014) published positive results of a comparative study of ovulation rate, prolificacy and live weight at birth traits in Thracian fine fleece ewes and their crosses with Booroola Merino.

The evaluation of the variance in the intra-breed linear structures, carriers of the F gene (FecB) in the only nucleus flock of sheep from the North-Eastern Bulgarian Fine Fleece breed - Shumen type (reared in Scientific Centre for Agriculture - Targovishte) is a necessary condition for choosing appropriate selection methods and schemes for extending genetic progress in the trait prolificacy throughout the population. The assessment of the influence of other genetic and environmental factors complements the information on which scientifically based decisions in the selection process are based. This motivates the present development.

The purpose of the study is to determine the influence of some factors on the biological prolificacy of sheep from the North-Eastern Bulgarian Fine Fleece Breed (NBFF) - Shumen type.

MATERIALS AND METHODS

The subject of the study are 617 sheep from the North-Eastern Bulgarian Fine Fleece breed (NBFF) - Shumen type, born in the period from 2013 to 2018 and raised in the Scientific Center for Agriculture in Targovishte. The biological prolificacy trait at different ages was investigated. 1839 observations of the biological prolificacy trait were recorded from the first to the fifth lambing of the ewes. The influence of the factors - breeding line, type of mating and year of birth was researched. An analysis of variance was performed based on a multivariate linear statistical model for each studied age (consecutive lambing), which has the following form:

$$\mathbf{Y}_{ijko} = \mu + \mathbf{A}_{i\,(1-6)} + \mathbf{B}_{j\,(1-2)} + \mathbf{C}_{k\,(1-6)} + \mathbf{e}_{ijko}$$

where:

μ - total mean;

$\mathbf{A}_{i\,(1-6)}$ - effect of the breeding line factor (fixed) - 6 levels (lines);

$\mathbf{B}_{j\,(1-2)}$ - effect of the type of mating factor (fixed) - 2 levels (intralinear and interlinear);

$\mathbf{C}_{k\,(1-6)}$ - effect of the factor year of birth (fixed) - 6 levels (2013-2018)

$\mathbf{e}_{ijk}$ - residual effects, ≈ N (O, δe2)

The differences between the levels of the studied factors were established on the basis of the degree of distribution measured by Student (Hayter, A. 1984):

$$(y_i - y_j)/S \sqrt{(1/n_i + 1/n_j)/2}$$

where: (yi - yj) - differences, between the average values of the levels of the studied factor; S - square deviation; ni and nj - number of observations (individuals) for the respective levels.

RESULTS AND DISCUSSIONS

The linear affiliation (Table 1) has a significant influence on the phenotypic manifestation of the trait biological prolificacy (P<0.001, P<0.01, P<0.05) up to 4.5 years. The value of the F-criterion is the highest at 3.5 years (F = 10.794) (P<0.001) when animals reach full body growth and development, as well as the most complete reproductive performance in our study. The factor - type of mating had a significant influence on the prolificacy of the first lambing only (F = 4.175) (P<0.05). According to the results obtained in our study, the year of birth does not have a reliable influence on the phenotypic manifestation of the biological prolificacy trait. The coefficients of variation of trait studies are high and range from 24.03% to 30.40%, which is characteristic of the trait and similar to data published by other authors. The variance of the first lambing in our study is the smallest, and then it increases until the third and gradually decreases until the last studied age. Stancheva et al. (2020) found an average coefficient of variation CV = 29% for the biological prolificacy of the same herd in which we conducted our study. The analysis of the results of the study shows the dominant influence of the genetic factor - linear affiliation on the trait of biological prolificacy. Staykova et al. (2022) found that the linear affiliation did not have a significant effect on wool yield, clean wool yield and pure fiber traits in sheep from the North-East Bulgarian Fine Fleece Breed (NBFF) - Shumen type.

Table 1. Analysis of variance of the trait biological prolificacy

Sources of variance	df	F	P	CV%
2.5 years of age				
Breeding line	5	7.049	***	25.49
Type of mating	1	4.175	*	
Year of birth	5	0.099	n. s.	
3.5 years of age				
Breeding line	5	10.794	***	28.99
Type of mating	1	0.137	n. s.	
Year of birth	4	0.324	n. s.	
4.5 years of age				
Breeding line	5	3.368	**	30.40
Type of mating	1	0.470	n. s.	
Year of birth	3	0.179	n. s.	
5.5 years of age				
Breeding line	5	0.548	n. s.	29.63
Type of mating	1	0.421	n. s.	
Year of birth	2	0.699	n. s.	
6.5 years of age				
Breeding line	5	0.736	n. s.	24.03
Type of mating	1	0.244	n. s.	
Year of birth	1	0.048	n. s.	

*** - P< 0.001; ** - P< 0.01; * - P< 0.05

The results in Table 2 show that ewes from line No. 61, descendants of a purebred Booroola Merino ram and homozygous for the F (FecB) gene, presented with positive LS-scores for the trait prolificacy up to 5.5 years (P<0.001, P<0.01, P<0.05), at 6.5 years of age the scores are close to the LS mean. Dimitrov (1997) published data on 88% superiority of the half-breed crosses compared to the purebred starting forms. Boykovski et al. (2002) found similar results for the same breed - a real increase of 86.80%, with a theoretically expected 82.50%. Slavova (2019) reported a relatively low live weight of ewes from line No. 377 with Booroola Merino genes in the Thracian Fine Fleece Breed, but with higher biological prolificacy than their peers. The purebred NBFF line No. 239 in our study was characterized by negative LS-estimates for the trait prolificacy at all ages studied, and line No. 583 - up to 4.5 years, after which the mean for the line was close to the total for the sample. The Australian Merino bloodlines in our study - No. 755, No. 777 and No. 845 showed negative LS-estimates for biological prolificacy up to 4.5 years of age. At the fourth and fifth lambing, the LS-estimates were divergent, close to the LS mean and without statistical assurance of the differences. After a long breeding activity, the linear contrasts, when compared with the purebred animals, become narrower, but they are indicative, especially at 3.5 and 4.5 years. The total LS average showed the highest level of trait prolificacy at 3.5 years (117.30%). Slavov (2007) studied the productivity of the North-East Bulgarian Fine Fleece Breed (NBFF) - Dobrudzhan type and indicated 118.60% and 130.10% biological prolificacy, respectively, at the first and second lambing. Stancheva et al. (2020) found a lower prolificacy (110.40%) at 3.5 years when studying the same herd of the Shumen type, and the authors recorded the highest prolificacy at the fourth lambing (115.80%). The data from Table 2 in our study confirm the positive effect of the introduction of the F (FecB) gene for high prolificacy in the genetic structures of the North-Eastern Bulgarian Fine Fleece breed.

The results in Table 3 reflect the effect of the type of mating factor. At 2.5 years old, the sheep, a product of inter-line mating, are presented with a positive deviation from the average for the studied sample. At later ages, LS-estimates are divergent, close to the mean and without statistical assurance of differences.

Table 2. LS-estimates (LSE) of the effect of breeding line on biological prolificacy (lambs/ewe) by parity

Line Factor levels	Age, years (parity)														
	2.5			3.5			4.5			5.5			6.5		
	n	LSE	LSM ± SE	n	LSE	LSM ± SE	n	LSE	LSM ± SE	n	LSE	LSM ± SE	n	LSE	LSM ± SE
№ 61	51	0.195 ABabc	1.299± 0.040	42	0.326 ABCDa	1.499± 0.052	33	0.201 alm	1.367± 0.062	13	0.077	1.230± 0.092	5	-0.049	1.001± 0.115
№ 239	126	-0.065 A	1.039± 0.025	106	-0.088 A	1.085± 0.033	77	-0.089 a	1.076± 0.040	44	-0.046	1.107± 0.052	10	-0.061	0.991± 0.084
№ 583	137	-0.056 B	1.047± 0.024	116	-0.061 B	1.112± 0.031	85	-0.060 l	1.105± 0.038	54	0.005	1.158± 0.047	21	0.001	1.053± 0.057
№ 755	144	-0.015 a	1.089± 0.024	140	-0.060 C	1.113± 0.029	89	-0.012m	1.153± 0.038	56	-0.054	1.099± 0.046	20	0.045	1.097± 0.058
№ 777	110	-0.027 b	1.077± 0.027	98	-0.072 D	1.101± 0.034	71	-0.022	1.144± 0.043	33	-0.020	1.133± 0.059	12	0.113	1.164± 0.077
№ 845	49	-0.032 c	1.072± 0.040	40	-0.044 a	1.129± 0.053	33	-0.017	1.149± 0.061	17	0.038	1.191± 0.082	7	-0.048	1.003± 0.097
Overall LS-mean, μ	**617**	**1.104 ± 0.013**		**542**	**1.173 ± 0.017**		**388**	**1.166 ± 0.020**		**217**	**1.153 ± 0.028**		**75**	**1.052 ± 0.034**	

Significance of differences within columns – when symbols identical:
A to Z – P< 0.001; a to k – P< 0.01; l to z – P< 0.05

Table 3. LS-estimates (LSE) of the effect of type of mating on biological prolificacy (lambs/ewe) by parity

Type of mating Factor levels	Age, years (parity)														
	2.5			3.5			4.5			5.5			6.5		
	n	LSE	LSM ±SE	n	LSE	LSM ±SE	n	LSE	LSM ± SE	n	LSE	LSM ± SE	n	LSE	LSM ± SE
Interlinear	262	-0.025	1.079±0.019	233	0.006	1.179±0.025	167	-0.014	1.152±0.031	127	-0.015	1.138± 0.035	38	0.016	1.068±0.047
Between the lines	355	0.025	1.129±0.016	309	-0.006	1.167±0.021	221	0.014	1.179±0.026	90	0.015	1.168± 0.038	37	-0.016	1.036±0.047
Overall LS - mean, μ	**617**	**1.104 ± 0.013**		**542**	**1.173 ± 0.017**		**388**	**1.166 ± 0.020**		**217**	**1.153 ± 0.028**		**75**	**1.052 ± 0.034**	

The results in Table 4 show the influence of environmental effects on biological prolificacy in sheep born and produced in subsequent years. Animals born in 2014 presented with negative LS-scores until the third lambing, after which values were close to the sample mean. Those born in 2017 show a positive deviation from the average LS of the two ages studied. Year of birth as a factor has a relatively weak effect on prolificacy with no significant differences between groups. Staykova et al. (2022) found that the year of birth had a significant influence on the wool productivity when studying the same herd. The trait level results in our study confirm those from the analysis of variance in Table 1. Regardless of the differences present in the absence of statistical certainty, it confirms the fact that prolificacy is a relatively conservative trait and cannot be relied upon for better reproductive outcomes by optimizing feeding and rearing conditions. The methods of genetic improvement, by increasing the potential for biological prolificacy, make it possible to achieve better and faster results in practice.

Table 4. LS-estimates (LSE) of the effect of year of birth on biological prolificacy (lambs/ewe) by parity

Year of birth Factor levels	Age, years (parity)														
	2.5			3.5			4.5			5.5			6.5		
	n	LSE	LSM ± SE	n	LSE	LSM ± SE	n	LSE	LSM ± SE	n	LSE	LSM ± SE	n	LSE	LSM ± SE
2013	66	-0.008	1.096± 0.035	66	-0.007	1.166± 0.042	65	0.015	1.180± 0.045	61	0.029	1.182± 0.046	35	-0.007	1.045± 0.049
2014	81	-0.008	1.097± 0.032	77	-0.021	1.152± 0.038	74	-0.005	1.161± 0.042	41	0.004	1.157± 0.053	40	0.007	1.059± 0.044
2015	160	0.008	1.003± 0.023	160	-0.010	1.163± 0.028	132	0.011	1.177± 0.033	115	-0.033	1.120± 0.035			
2016	139	-0.005	1.099± 0.026	127	0.011	1.184± 0.032	117	-0.021	1.145± 0.036						
2017	111	0.013	1.117± 0.028	112	0.027	1.200± 0.033									
2018	60	-0.001	1.103± 0.036												
Overall LS-mean, μ	**617**	**1.104 ± 0.013**		**542**	**1.173 ± 0.017**		**388**	**1.166 ± 0.020**		**217**	**1.153 ± 0.028**		**75**	**1.052 ± 0.034**	

CONCLUSIONS

The linear affiliation of sheep from the North-Eastern Bulgarian Fine Fleece Breed (NBFF) - Shumen type has a significant effect on biological prolificacy up to the third lambing. The type of mating has a significant effect on biological prolificacy at first lambing only. No effect of year of birth on biological prolificacy was observed at any of the ages studied.

Sheep from the line No. 61 with FecB gene from Booroola Merino are superior in prolificacy the purebred and the lines with Australian Merino genes up to 4.5 years.

The biological prolificacy increaseed by the second lambing and was highest at 3.5 years (117%). Prolificacy increases at the second lambing and gradually decreases until 6.5 years.

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