

SOME PRODUCTIVE AND REPRODUCTIVE TRAITS IN SHEEP FROM THE BULGARIAN DAIRY SYNTHETIC POPULATION (BDSP) AND ITS CROSSES WITH LACAUNE AND ASSAF: 2. PHENOTYPIC PARAMETERS

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Abstract: Bulgarian Dairy Synthetic Population (BDSP) and its crosses with other dairy breeds are the most numerous sheep population in Bulgaria. There are significant phenotypic diversities and different levels of productivity. The aim of the study is to research and characterize the phenotypic parameters of the main productive and reproductive traits in sheep from the Bulgarian dairy synthetic population and its crosses with the breeds Lacaune and Assaf. The study includes a total of 3212 ewes BDSP and their crosses with Assaf and Lacaune. Studied trait were: milk yield for a standard 120-day period of I, II and III lactation, biological fertility of the 1st, 2nd and 3rd lambing and the trait - live weight of different age categories. The software product SYSTST 13 and SPSS - Descriptive statistics were used to conduct the study. With the highest milk yield of the 1st, 2nd and 3rd lactation were the sheep BDSP x Lacaune - 186.28 l, 194.03 l, 200.56 l, followed by BDSP x Assaf - 184.27 l, 191.87 l and 198.64 l and those of BDSP - 134.18 l, 139.48 l and 144.33 l. The average phenotypic values of the traits live weight at weaning, at 18 months and 2.5 years are close - respectively in BDSP - 25.21 kg, 60.59 kg and 65.50 kg, for BDSP x Lacaune - 25.17 kg, 60.52 kg, 65.44 kg and for BDSP x Assaf - 25.19 kg, 60.58 kg, 65.67 kg. Fertility indicates the highest average values of the crosses BDSP with Lacaune from 1.53 to 1.59, followed by BDSP x Assaf from 1.40 to 1.46. The lowest fertility rate had the ewes from BDSP from 1.22 to 1.25.

Key words: BDSP, Lacaune, Assaf, phenotypic, milk yield, fertility

Introduction

Globally, the consumption and demand for sheep's milk is constantly increasing, but on the other hand the trend of its production is negative. This is caused by decreasing interests in the rearing of dairy breeds of sheep and the shift of farmers to raise sheep for meat. This trend is observed in most developed countries, including Bulgaria, and the fact is due to several reasons. The lack of skilled labor, excessive urbanization, as well as the existence of milking costs and additional wages. Sheep's milk products are gaining more and more market size due to their quality and nutritional value - the higher content of protein, fat, vitamins and minerals compared to milk obtained from other species (*Park et al., 2007; Pandya and Ghodke, 2007*). From here come the favorable prospects for increasing the production and processing of sheep's milk.

Purposeful work on the establishment of specialized dairy sheep in Bulgaria began in the late 70's on a pre-defined program. Currently, the most numerous, most widespread and newest Bulgarian specialized breed of sheep for milk is the Bulgarian Dairy Synthetic Population (BDSP). It is created through complex reproductive crossbreeding and purposeful selection. Bulgarian dairy synthetic population was registered with certificate №10645 (property of AI-Shumen) from 30.06.2005 (*Stancheva et al., 2014*). Sheep and rams of the breeds: Blackhead Pleven, local Stara Zagora, Avasi, East Friesian and others take part in the breed formation. The average genetic potential of ewes for the milking period is about 150 to 200 liters, and the realization of this trait depends mainly on the provided conditions of feeding and rearing. The first insemination usually takes place at 18 months, but is also possible at 9-10 months of age. Biological fertility is about 150 lambs per 100 ewes.

In the methodological guidelines for creating the synthetic population of sheep for milk, *Hinkovski et al. (1984)* indicate that the breeding target is 250 to 300 liters of milk per lactation. The results of studies by a number of authors on the milk productivity of different types of crossbred sheep, which later formed the synthetic population of sheep for milk (*Boikovski, 1982; Djorbineva, 1984; Todorova, 1987; Tsvetanov, 1989; Ahmed, 1991; Dimov, 1995; Stancheva, 2003; Iliev, 2011; Ivanova, 2013; Slavova et al., 2015; Stancheva et al., 2018.*) show that the breeding goal in the creation of the synthetic population has not been achieved. The achieved level of milk productivity - below 200 liters during lactation is much lower than the set breeding goal.

According to *Stancheva (2003)*, the milk yield of sheep from the synthetic population of the herd at the Agricultural Institute in Shumen for animals born in 1987-1999 is an average of 99.18 liters for first lactation and 101.96 liters for second lactation and an average biological fertility of 1.37. In a study by the same author for 2008, the milk yield of the herd in ZI - Shumen averaged at 104.24 l

(*Stancheva et al., 2011*). In the herd of the Institute of Animal Sciences - Kostinbrod for the period 2006 - 2009 an average milk yield was established for a 120-day milking period for ewes of I lactation - 95.86 l, II - 95.89 l and 111.68 l of III lactation (*Ivanova, 2013*). The fertility rate of sheep from the synthetic population established by *Stancheva (2003)* were - 1.335 - 1.412, respectively of I and II lactation for the Shumen region and by *Dimov and Kuzmanova (2007)* 1.34 for the Plovdiv region. Against the background of the high achievements in the field of dairy sheep breeding in the developed western European countries (*Fuente et al., 2006; Gutierrez et al., 2007*) for the breeds Awasi and Asaf - 297 l, and in Israel (*Pollot and Gootwine, 2004*) for the breed - Asaf 334 l. *Slavova et al. (2021)* reports low levels of growth intensity traits in BDSP reared in AI. Stara Zagora. The above-cited results obtained by our specialized breed for milk are significantly lower.

Dominant in recent years are sheep from BDSP and its crosses with other dairy breeds, bred in most private herds. This in turn leads to the existence of significant, scientifically based phenotypic and genetic diversity and different levels of productivity (*Stancheva et al., 2014*).

In addition to the traditional Bulgarian sheep breeds, more and more sheep breeders are turning to various foreign breeds in search of more profitable animals for breeding.

The Lacaune and Assaf breeds are exactly the ones that many sheep breeders already prefer because of their good productivity and the suitable conditions in our country for their breeding.

Assaf is a synthetic population and was created by crossing the local Awasi breed with rams from the German East Frisian dairy breed. The average milk yield for lactation from Assaf in different years varies from 330 to 350 liters. In some farms it reaches 400 liters. The average fertility is 150-160 lambs per 100 sheep every 8 months. This high fertility rate is one of the reasons why this breed particularly is profitable to raise.

Another extremely valuable breed is the Lacaune breed. It is one of the sheep breeds with highest milk yield in the world. It was created in France in the 19th century on the basis of several local sheep populations. The breed is characterized by high milk yield - 270-320 liters. The fertility of the sheep is between 190-200 lambs per 100 sheep.

Among the dairy breeds, the total share of sheep belonging to the Bulgarian dairy synthetic population is the largest (about 70%). This in itself means that a lot of effort and serious selection work is needed to build its breeding structure and its development. The fact is that there is a significant phenotypic and genetic diversity and different levels of productivity in sheep from BDSP, it is necessary to consolidate the population (*Stancheva et al., 2014*).

The aim of the study is to research and characterize the phenotypic parameters of the main productive and reproductive traits in sheep from the

Bulgarian dairy synthetic population and its crosses with the breeds Lacaune and Assaf.

Material and Methods

The increasing number of animals under breeding control from Bulgarian dairy synthetic population in the country is one of the reasons to study the phenotypic parameters of some productive and reproductive traits of these sheep.

The study includes a total of 3212 ewes from Bulgarian dairy synthetic population and crosses with Assaf and Lacaune, this is a continuation of research of the genotypic parameters of some productive and reproductive traits BDSP and its crosses and it was conducted on the same sheep population.

All fifteen farms included in the study are members of the NGO "Association for breeding and rearing of dairy Sheep". Studied traits were: milk yield for a standard 120-day period of I, II and III lactation, biological fertility of the 1st, 2nd and 3rd lambing and the trait - live weight of the different age categories.

The control of milk yield was performed during the milking period, and over the years four controls were performed. The milk yield data refer only to the milk obtained from the ewes after complete weaning of the lambs. The quantity of milk is presented in volume units (ml). The individual milk yield of each ewe for the control day was calculated by multiplying the amount of milk obtained by the morning individual control by a herd ratio representing the ratio: morning + evening milk / morning milk. The milk yield for a 120-day milking period was calculated as the sum of the milk yields from the individual control periods of each sheep. Live weight was measured individually at weaning, at 18 months and 2.5 years.

The examined traits are controlled and registered according to a standard method and instructions, provided in the Instruction for control of the productive qualities and grading of the sheep in Bulgarian legislation (2003-2013). The necessary primary information for the study was obtained from the herd books and primary documentation kept in the "Association for breeding and rearing of dairy Sheep".

The phenotypic parameters of the productive and reproductive indicators of the Bulgarian dairy synthetic population and its crosses were studied taking into account the influence of genetic and non-genetic factors on the studied traits.

Used software products to perform the statistical analysis of phenotypical values of the productive and reproductive traits in BDSP and its crosses, mean phenotypic values of fertility traits in 1st, 2nd and 3rd lambing and mean

phenotypic values of traits live weight at weaning, at 18 months and 2.5 years, mean phenotypic values of the trait milk yield for 120 days at the 1st, 2nd and 3rd lactation were SYSTAT 13 and SPSS.

Results and Discussion

Table 1 presents the phenotypic values of the main statistical parameters of the traits: fertility in the first, second and third lambing; live weight at weaning, at 18 months and at 2.5 years of age and milk yield in the first, second and third lactation for a standardized milking period of 120 days. The average values of the listed traits are presented graphically, such as the fertility in Figure 1, live weights in Figure 2, and milk yield in Figure 3.

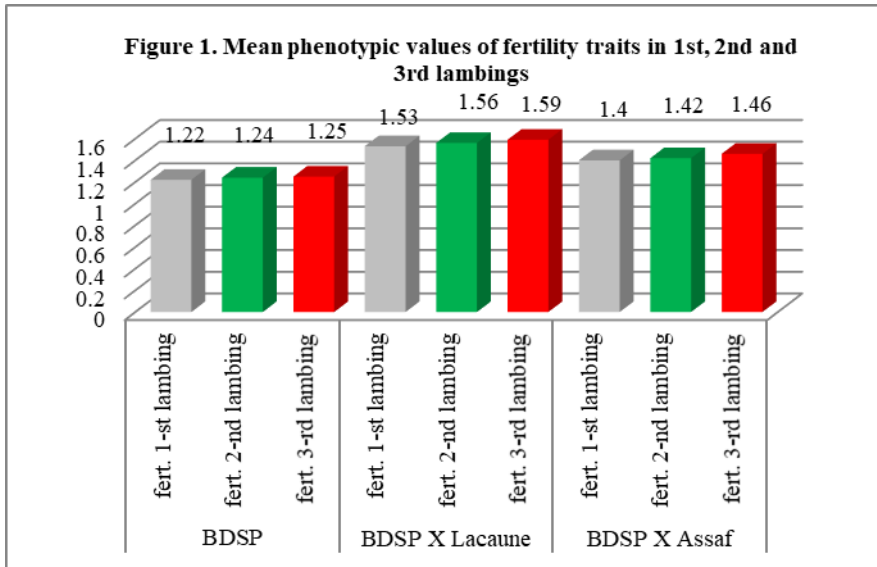
One of the traits that has received serious attention in recent years, and which is currently one of the main selection traits, is fertility. The phenotypic indicators of the trait are determined mainly for three of the periods of development of the ewes - the first, the second and the third lambing, as mentioned in the literature the limits of the biological fertility for the breed BDSP is from 1.2 to 1.5, and for Lacaune and Assaf, respectively, from 1.5 to 1.9 and 1.3 to 1.6.

The results reported by us are in unison with those published in the literature (*Stancheva, 2003; Ivanova, 2013; Dimov and Kuzmanova, 2007; Stancheva et al., 2018*). It is worth noting that in all three lambings in a row the minimum and maximum values of fertility remain the same in all three studied groups BDSP 1-2 BDSP x Assaf 1-2 and BDSP x Lacaune 1-3, taking into account that only in animals crossed with Lacaune had triplets. In the fertility trait, the differences between the standard deviation and the coefficient of variation (CV) are very small in all three groups, but on the other hand we report the highest CV from 31% to 35% in this indicator, compared to the others included in the study. This is due to the fact that the minimum and maximum values are from 1 to 3, and the standard deviation from the average is from 0.416 to 0.506. At such low minimum and maximum values and such Std., naturally CV is so high.

Figure 1 shows the average phenotypic values of fertility in 1st, 2nd and 3rd lambing. The results show that with the highest average values are characterized the crosses of BDSP with Lacune from 1.53 to 1.59, followed by BDSP x Assaf from 1.40 to 1.46 and with the lowest fertility rate are the ewes from BDSP from 1.22 to 1.25. The presented graph clearly shows the positive trend in fertility from the 1st to the 3rd lambing and in the three groups included in the study, as the highest average values were reported in the 3rd lambing.

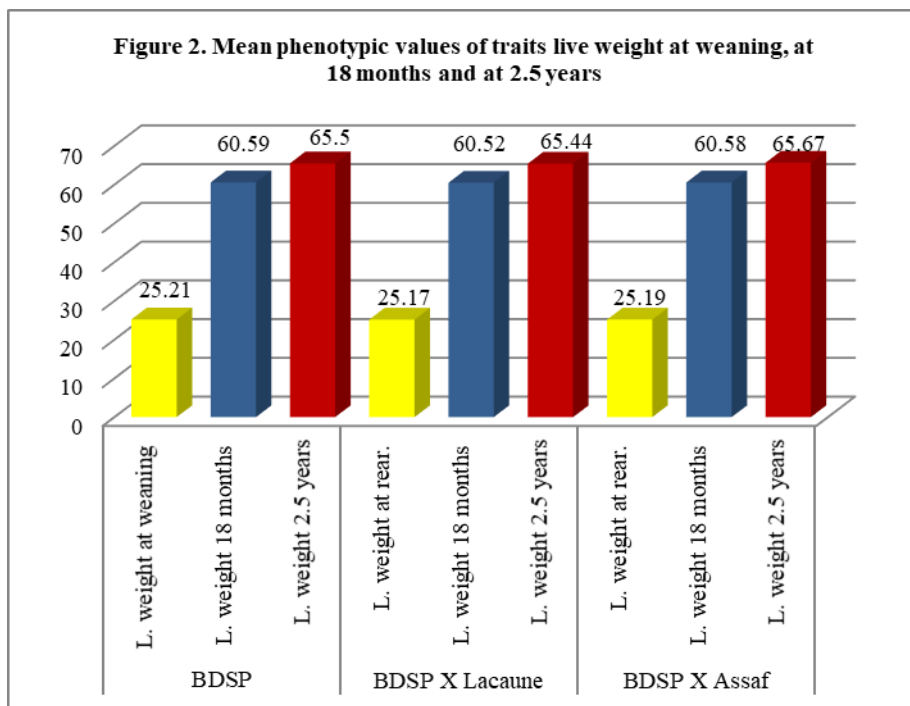
Table 1. Phenotypic values of the main statistical parameters of the productive and reproductive traits in SPBM and its crosses

Trait	Main statistical parameters	BDSP n=1114	BDSP x Lacaune n=1046	BDSP x Assaf n=1052
Fertility at 1st lambing	Min. value	1	1	1
	Max. value	2	3	2
	Standard Deviation	0.416	0.506	0.491
	Coefficient of variation	34	33	35
Fertility at 2nd lambing	Min. value	1	1	1
	Max. value	2	3	2
	Standard Deviation	0.424	0.501	0.495
	Coefficient of variation	34	32	35
Fertility at 3rd lambing	Min. value	1	1	1
	Max. value	2	3	2
	Standard Deviation	0.431	0.496	0.499
	Coefficient of variation	35	31	34
Live weight at weaning	Min. value	23	24	23
	Max. value	27	27	27
	Standard Deviation	0.766	0.784	0.797
	Coefficient of variation	3	3	3
Live weight at 18 months	Min. value	57	58	56
	Max. value	63	63	63
	Standard Deviation	1.138	1.090	1.146
	Coefficient of variation	2	2	2
Live weight at 2.5 years	Min. value	62	60	62
	Max. value	68	68	70
	Standard Deviation	1.061	1.222	1.249
	Coefficient of variation	2	2	2
Milk yield at 1st lactation	Min. value	123	168	166
	Max. value	148	216	204
	Standard Deviation	5.347	7.628	8.214
	Coefficient of variation	4	4	4
Milk yield at 2nd lactation	Min. value	130	174	176
	Max. value	150	216	216
	Standard Deviation	5.384	6.814	7.117
	Coefficient of variation	4	4	4
Milk yield at 3rd lactation	Min. value	132	180	178
	Max. value	152	234	236
	Standard Deviation	4.425	6.979	7.039
	Coefficient of variation	3	3	3



The obtained values for the traits characterizing the growth intensity - live weights of the animals during the different periods of their development are not characterized by great variability. We report very similar phenotypic values in live weight at weaning. The maximum of the trait is the same for all farms - 27 kg, and the minimum differs by one kilogram in plus for crosses with Lacaune - 24 kg, so the average, as well as the standard deviation and coefficient of variation are almost identical. With the highest standard deviation for the above-mentioned trait are, the crosses with Assaf - 0.797. We established also the highest average value of 25.21 kg in BDSP.

The other trait that is not only decisive in terms of growth intensity, but is also related to the fertility and milk productivity of sheep, is the live weight at 18 months of age. Here we also report a slight variation, as the lowest minimum value is for crosses with Assaf - 56 kg and the highest is for crosses with Lacaune - 58 kg. At the maximum of the indicator there are no differences in the three groups - 63 kg. The average values vary within extremely narrow limits. The standard deviation and the coefficient of variation are almost identical and are presented in Table1.



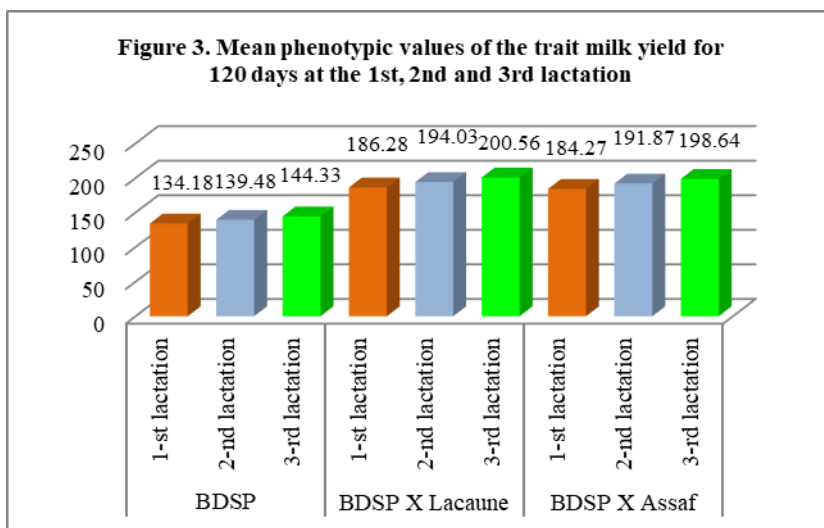
The live weight at 2.5 years in ewes is essential for fertility, prolificacy and subsequently for milk productivity. Both too low and too high weight lead to unsatisfactory results in the above-mentioned trait. From the reported phenotypic values of the indicator live weight of 2.5 years in Table 1 it can be seen that the difference in the minimum values for the trait is within narrow limits, with a lower minimum value are the crosses with Lacaune - 60 kg, and in BDSP and its crosses with Assaf we established 62 kg. At the maximum, BDSP x Assaf have the highest value - 70 kg, they also have the highest average phenotypic value for the trait - 65.67 kg. The differences in the mean values are presented in Fig. 2. As can be seen, the values of the traits that determine the intensity of growth are in extremely narrow limits, which determines the low values of the standard deviation and the coefficient of variation.

The slight variation of the phenotypic values of the traits characterizing the growth intensity - live weights of the animals during the different periods of their development are indicative of the presence of consolidation of the studied sample of the population.

The main selection trait, which is also the main productive one in the Bulgarian dairy synthetic population, as well as in its crosses is the milk yield for a

120-day standardized milking period. In the Breeding program of the NGO the control of the milk productivity is set as main, therefore in our research we have included the phenotypic values of the main statistical parameters for the three stages of production 1st, 2nd and 3rd lactation. The results obtained by us are presented in Table 1 and Fig. 3.

The highest phenotypic mean value of the milk yield of the 1st lactation is characterized by crosses with Lacon - 186.28 l, and the lowest is BDSP - 134.18 l. In BDSP x Assaf the average milk yield is 184.28 l. The lowest minimum was reported for BDSP - 123 l, and for crosses with Lacaune we have established the highest minimum and maximum milk yield for the period with values of 168 l and 216 l. With this indicator the variability is clear, so the standard deviation is in ranges from 5.35 for BDSP to 8.21 for BDSP x Assaf. The coefficient of variation has similar values for the three studied groups.



In our analysis of the results we found that the average phenotypic values of milk yield for the 1st, 2nd and 3rd lactation for 120 days have a positive trend with the progression of lactations to the 3rd and for the three included in the study genetic groups. With the highest average value for the 2nd lactation are again the crosses with Lacune - 194.03 l, and with the lowest BDSP - 139.48 l, as with the crosses with Assaf the average milk yield is 191.87 l. It gives the impression the close values, and apparently the equalized genetic potential which have the crosses of BDSP with Assaf and Lacune. In the third lactation in a row, the values

established by us are in unison with the previous two lactations. The crosses with Lacaune are characterized by the highest phenotypic mean value - 200.56 l, the reported value for crosses with Assaf is slightly lower - 198.64 l. The lowest average for the trait again belongs to the animals from the Bulgarian dairy synthetic population - 144.33 l. The coefficient of variation for the third lactation is 3 for all three groups, and Std. is in the range of 4,425 to 7,039. For the trait milk yield, the highest value was reported on the 3rd lactation at the crosses with Assaf - 236 l for 120 - day standardized milking period.

Conclusions

1. The average phenotypic values of the traits characterizing the growth intensity of the three studied groups of sheep - live weight at weaning, at 18 months and 2.5 years are close - respectively in BDSP - 25.21 kg, 60.59 kg and 65.50 kg, in BDSP x Lacaune - 25.17 kg, 60.52 kg, 65.44 kg and in BDSP x Assaf - 25.19 kg, 60.58 kg, 65.67 kg, as the standard deviation vary within very narrow limits, and the coefficient of variation is from 2 to 3%.
2. The fertility trait, which is the main reproductive trait, indicates the highest average values at the crosses of BDSP with Lacaune from 1.53 to 1.59, followed by BDSP x Assaf from 1.40 to 1.46. The lowest fertility rate had the ewes from BDSP from 1.22 to 1.25, as the coefficient of variation of the trait is from 31 to 35%.
3. With the highest milk yield of the 1st, 2nd and 3rd lactation are the ewes BDSP x Lacaune - 186.28 l, 194.03 l, 200.56 l, followed by BDSP x Assaf - 184.27 l, 191 , 87 l, 198.64 l and with the lowest value of the trait were BDSP - 134.18 l, 139.48 l and 144.33 l. The mean standard deviation levels for this indicator are relatively low at 3 to 4%.
4. From the obtained results we can conclude that the crosses F1 of BDSP with the breeds Assaf and Lacaune significantly increase the values of the main selection traits milk yield and fertility.
5. The controlled inclusion of the Lacaune and Assaf breeds in the BDSP breeding schemes could lead to a phenotypic consolidation of the traits, as well as an increase in the milk yield and fertility of the population.

Proizvodne i reproduktivne osobine ovaca bugarske mlečne sintetičke populacije (BDSP) i njenih meleza sa rasama Lacaune i Assaf: 2. Fenotipski parametri

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Rezime

Bugarska mlečna sintetička populacija (BDSP) i njeni melezi sa drugim mlečnim rasama su najbrojnija populacija ovaca u Bugarskoj. Postoje značajne fenotipske raznolikosti i različiti nivoi produktivnosti. Cilj rada je istraživanje i karakterizacija fenotipskih parametara glavnih proizvodnih i reproduktivnih osobina ovaca bugarske mlečne sintetičke populacije i njenih meleza sa rasama Lacaune i Assaf. Istraživanje je obuhvatalo ukupno 3212 ovaca i njenih meleza sa rasama Lacaune i Assaf. Ispitivane osobine su: mlečnost za standardni period od 120 dana I, II i III laktacije, biološka plodnost 1., 2. i 3. jagnjenja i osobina - živa masa različitih starosnih kategorija. Za sprovođenje studije korišćen je softverski proizvod SYSTST 13 i SPSS – deskriptivna statistika. Sa najvećim prinosom mleka u 1., 2. i 3. laktaciji bile su ovce BDSP x Lacaune - 186,28 litara, 194,03 litara, 200,56 litara, zatim BDSP x Assaf - 184,27 litara, 191,87 litara i 198,64 litara – BDSP 134,18 litara , 139,48 litara i 144,33 litara. Prosečne fenotipske vrednosti osobina mase pri odbijanju, sa 18 meseci i uzrastu od 2,5 godine su bliske - respektivno - kod BDSP - 25,21 kg, 60,59 kg i 65,50 kg, kod BDSP x Lacaune - 25,17 kg, 60,52 kg, 65,4 kg, i kod BDSP x Asaf - 25,19 kg, 60,58 kg, 65,67 kg. Plodnost ukazuje na najveće prosečne vrednosti kod meleza BDSP x Lacaune od 1,53 do 1,59, zatim BDSP x Assaf od 1,40 do 1,46. Najnižu stopu fertiliteta imale su ovce BDSP od 1,22 do 1,25.

Ključne reči: BDSP, Lacaune, Assaf, fenotip, mlečnost, plodnost

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