UDK 636.082.4

Izvorni znanstveni članak
Original scientific paper

EFFECT OF SEASONALITY ON LITTER SIZE TRAITS IN BLACK SLAVONIAN AND "NERO DI PARMA" PIGS

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Summary

The aim of this study was to analyse the litter size traits in two genotypes of pig population with black coat: Black Slavonian (BS) and "Nero di Parma" (NP). Data analysis included records from the 1st to 4th parity separately, and all parities (from 1st to 11th) for the following traits: Total Number of Born (TNB), Number of Born Alive (NBA), and Number of Weaned (NW) piglets, collected from 296 BS and 421 NP sows. Litter size traits from 1st to 4thparitywas analysed separately for each breed and ANOVA Repetead Measure test was used to calculate the difference between parities. The analysis of seasonality in all parities was performed using the General Linear Model.Significant differences (P<0.05) between-parity in BS were observed in the 1st and 3rd as well in the 1st and 4th parities for TNB and NW. Only for the NBA difference (P<0.05) was found between 1st and 3rd parities.Differences (P<0.05) in NP pigs were reported between the 1st and 3rd as between 1st and 4th parity for TNB and NBA. First-parity sows for NW shows significant differences (P<0.05) in relation to 2nd, 3rd and 4th parity. In all parities analysed according to the seasons significant differences was recorded between summer and autumn period for TNB (P<0.05) in BS. Difference (P<0.05) was also obtained for NBA between spring and autumn, as well as for summer and autumn season. In all parity analysis in BS pig, the NW (P<0.05) showed differences only between spring and summer period. Season in all parity analysis had a significant impact on litter size traits in NP pig. Differences (P<0.05) was obtained for TNB, NBA and NW among spring-winter, summer-winter and autumn-winter period.

Key words: seasonality, litter size traits, Black Slavonian, "Nero di Parma" pig.

Introduction

Croatian Black Slavonian (BS) and Italian Black pig from Parma, more commonly known as "Nero di Parma" (NP),are an integral part and valuable genetic reserve of biodiversity, as well as of cultural heritage of local and national communities (Menčiket al., 2015).The origin of these two local pig breeds has been present in the records of the National Associationsof Breeders for more than century and a half (Karolyi et al., 2010; Sabbioniet al., 2011). BS pigsare bred and raised mostly in the Pannonian plains (Karolyiet al., 2010)and NP pigs in the Apennine mountains in the Emilia Romagna region and along the valley of the Po river (Sabbioniet al., 2011). From the middle of the last century the population of BS and NP pigs drastically decreased, primary as a consequence of introducingthe Western pigs as Large White (LW), Landrace(L) and their hybrid lines, with higher genetic potential for meat productionandhigher reproductive efficiency compared to local pig breeds (Uremović, 2004; Sabbioniet al., 2009).Untill the 1990's the survival of these local breeds was endangered.However, with the introduction of protection measures and systematic breeding procedures with the different programs focused on the breeds' revitalisation, the number of breeding individualscontinuously increases (Croatian Agricultural Agency, 2015).

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In current breeding programs for local pig breeds an emphasis is placed on improving their reproductive traits to increase the number of weanedpigletsper year/litter(Brkićet al., 2014; Menčiket al., 2015). It has been considered that seasonality influence on reproductive performance, especially on litter size traits of outdoor breeding sows (Berger et al., 1997). During the year the ability of reproduction in outdoor breeding sows are significantly affected by heat stress, photoperiod,humidity, lactation catabolism, use of the boar and socio-environmental factors in the group (Quesnel et al., 2005). Also, seasonality could influence on delayed puberty in young gilts anddecreased proportions of sows that are exhibiting estrus after weaning (Peltoniemi and Virolainen, 2006; Bertoldo et al., 2009). It is to expected that the lowest fertility rate is observed from July to August, in comparison with the highest fertility rate observed in the late winter period from February to March (Auvigne et al., 2010).

Black Slavonian and NP pig breedsare increasinglypresent inthe local pig populations despite theirinferior growth and reproduction, compared to modern meat genotypes with the primary goal of the production of high quality traditional products.Due to a strong natural selection as well as the breeding procedures through the years the local breeds of pigs with black coated genotype have become more suitable for extensive or semi-intensivesystems(Miaoet al., 2004; Salajpalet al., 2013).Genetic predisposition of pigs with "*black genotype*"breed and raised in Mediterranean region and it's surrounding territories enabled them to develop the adaptive mechanisms for fat storage during the period of reduced feed in extensive systems- so called *thrifty* genotype. In comparison with Western pigs as LW, L and their crossbreeds, reduced condition of feeding could contribute to lower reproductive precocity (Gonzales-Añover et al., 2010). The management of reproduction in BS and NP pigs is based on the *low-input* cost, especially regarding the management with *chiefly limited investments,* to provide more natural environmental conditions of the litters during the nursering period. Therefore, the management of the litters and seasonal influence have a significant effect on litter size performancein local pig populations (Berger et al., 1997). Significant decrease in litter size traits influence on the number of reproductive animals that reduces genetic diversity (Sabbioniet al., 2011) and breeding selection procedures based on phenotype values for the prediciton of the reproductive capacity (Ekert Kabalinet al., 2013).

The first aim of this study was to describetwo local pig breeds, BS and NP concerninglitter size traits(Total Number of Born – TNB, Number of Born Alive – NBA, and Number of Weaned piglets - NW). Second aim was to analyse,within each breed, the influence of parity from the 1st to 4th parities and season through all parites.

Material and methods

Data of farrowing records for BS were collected from the database of the Herdbook registry managed by Croatian Agricultural Agency with the collaboration of the register fromthe Association of Breeders of Black Slavonian pigs, Baranja and Western Sriem (Association of Breeders „*Fajferica*"). The litter size data for NP pigs were collected from theHerdbook managed by the Italian Swine Breeders Association in accordance with the Association of Breeders of *Nero di Parma*pig. Data includedlitter size traits for 296 reproductive sows of BS with 969 analyzed litters and 421 sows of NP with 1398analyzed litters during the period from January 2007 until January 2014 for both pig breeds. The record of each sow includedits identity, parity,farrowing season, size of the litters with TNB, NBA and NW. Litter size data by breed were analyzed separately from the 1^{st} to the 4^{th} parity and presented as Mean±Standard Errors (Mean±SE). For each breed ANOVA Repetead Measure test was used to calculate the difference between parities.For all paritiestogether (from the 1^{st} to the 11^{th}), seasonality was calculated separately for BS and NP pig breed using the General Linear Model procedure in the SAS statistical package (SAS, 2010). The model that best fitted the litter size data is represented as follows:

$$\text{model: } y_{ijk} = \mu + P_i + H_j + S_k + e_{ijk}$$

where: y_{ijk} – observed trait (TNB, NBA and NW); μ – population mean; P_i– parity (i= 1^{st} to 11^{th}); H_j – herd type (j= 1, 2)reffers to farm farrowing management whereindoor farrowing was consideredas the type 1 and outdoor farrowing as the type 2; S_k –seasons (k=1, 2, 3, 4)was formed on the basis of the farrowing data obtained for each sow and it was included in the all parity analysed. Seasons have been formed as fixed class effect with four levels. First level includedsows that farrowed in the Spring (SP) season from month March to May,second level those with farrowing obtainedfrom June to August as Summer (SM) season. Third levelwas Autumn (AT) season from September to November and the fourth level from December untill theend of February as Winter (WT) season, and e_{ijk} – residual.

Results and discussion

This study was performed to describe litter size performance in two local breeds BS and NP, from the first to fourth parities and to evaluate the influence of the season on litter size including all

parities analysed. Many studies have documented that litter size in sows increases through the fourth and fifth pregnancy as was also showed in this research. The analysed litter size traits as TNB, NBA and NW in BS and NP from the first to fourth parities are illustrated in Table1.Litter size data in BS pig showed significant difference (P<0.05) between first and third and first and fourth parities for TNB and NW. The results for NBA in BS illustrate the differences (P<0.05) only between first and third parities. Significant difference (P<0.05) in NP were obtained in TNB and NBA between first and third as well between first and fourth parity. For the NW, difference (P<0.05) was also described between first and all other (second, third and fourth) parities.Horak et al. (2005) noted higer value of TNB (10.82-11.77), NBA (10.10-10.96) and NW (9.36-9.86) in the local Czech autochtonous Přěštice-Black Pied sows with good maternal properities and high fertility.

Franci and Pugliese (2007) described that reproductive traits as TNB and NW in Italian local pig population differed according to the breed. Slightly lower values in relation to this study were recorded in other black genotypes of pigs as: Mora Romagnola with 7.13±2.58 TNB and 5.47±2.41 NW, Calabrese with 6.12±2.64 TNB and 5.45±2.35 NW and Nero Siciliano with 6.78±1.22 TNB and 6.02±1.60 NW. The litter size traits by parity of BS and NP are similar to other Mediterranean breeds of pigs such as Iberian (IB) with 6.45 TNB and 6.07 NW, respectively (Barba et al., 2001). Saura et al. (2015) reported similar values for all analysed litters with 7.39±2.34 TNB and 7.06±2.25 NBA for IB pig compared to the results of this study, especially for data reffering to fourth parity in BS pigs. Similar result has been described in litter size data of Alentejano breed of pigs raised in southern Portugal, with 7.9±0.7 TNB and 7.7±0.6 NBA (Charneca et al., 2010).

Considering the effects included in the model of calculation,litter size traits in BS and NP analysed in all parities according to the seasons are presentedin Table 2.

The present study showed that litter size traits in BS and NP pig differ significantly between seasons.In BS pig significant differences was recorded between SM and AT period for TNB (P<0.05). Difference (P<0.05) was also obtained for NBA between SP and AT, as well as for SM and AT season. In all parity analysis in BS pig, the NW (P<0.05) showed differences only between SP and SM period. Season in all parity analysis had a significant impact on litter size traits in NP pig. Differences (P<0.05) was obtained for TNB, NBA and NW among SP-WT, SM-WT and AT-WT period. Obtained results showed that the lowest NW in BS and NP pigs analyzed by season was recorded in the SP and WT period because of possible unfavorable influence of environmental conditions.Variation in litter size traits among season may be the result of the „*social and heat stress interaction*" during the SM which leads to the seasonal infertility with lower litter size

performance during the AT and early WT period (Quesnel et al., 2005).As other black Mediterranean pigs with high rusticity, the Greek black pig also has seasonal reproductive activity and produces two litters *per* year, consisting of 8.48±1.94 TNB and 7.04 NBA (Laliotis, 2001; Michailidou et al., 2014). Gamma et al. (2014) reported sligtly lower values in Alentejano breed with 5.87 NBA and the significant effect of month of farrowing on the analysed trait which farrowed 0.5 piglets more per litter in SM compared to WT period.The association between seasonality and litter size values indicates that further efforts in the herd health management in the local pig populations could improve reproductive traits (Tummaruk et al., 2001). The study results provided original elements to discuss the importance of the piglet management during the weaning period, with the possible future investigations of the sow group housing as an important environmental risk factor for the seasonal infertility.

Conclusions

Based on the results presented and the variability in two pig breeds it is important to improve the reproduction management in the local pig breeds. It is obvious that the future management tools in reproduction of the local pigs could reduce losses during the postnatal period untill weaning. Improvement of the reproductive traits will help the recovery of the BS and NP pigs, also the breeding procedures as well as their competitiveness with the commercial pig breeds. In conclusion, our study confirmed the significant influence of the season on litter size traits.

Acknowledgements

The authors wish to thank to two National Associations: the Association of Breeders „Fajferica" and the Association of Breeders of Nero di Parma pig, as well as to Croatian Agricutural Agency and Italian Association of National Breeders on the data availability.

Table 1. - Means with Standard Errors (Mean±SE) for litter size traits in Black Slavonian (BS) and "Nero di Parma"(NP) pig breedsanalysed according to parity number

Breed	Analysed trait (Mean ±SE)	Parity number			
		First parity n=296	Second parity n=205	Third parity n=160	Fourth parity n=116
Black Slavonian pig	TNB	6.02^{a}±0.12	6.66±0.15	7.19^{b}±0.17	7.39^{b}±0.20
	NBA	5.73^{a}±0.23	6.30±0.28	7.35^{b}±0.32	6.94±0.38
	NW	5.16^{a}±0.14	6.11±0.17	6.55^{b}±0.19	6.68^{b}±0.22
"Nero di Parma" pig		First parity n=421	Second parity n=372	Third parity n=244	Fourth parity n=140
	TNB	7.28^{a}±0.10	7.71±0.09	8.11^{b}±0.14	8.32^{b}±0.20
	NBA	6.86^{a}±0.11	7.33±0.10	7.80^{b}±0.15	8.04^{b}±0.20
	NW	5.51^{a}±0.12	6.24^{b}±0.10	6.34^{b}±0.16	6.77^{b}±0.21

TNB – Total Number of Born; NBA – Number of Born Alive; NW – Number of Weaned piglets; n – number of analysed litters; Mean with standard error (Mean±SE)with superscripts (a,b) in the same row differ significantly (P<0.05)

Table 2. - Least Square Means with Standard Errors (LSM±SE) for litter size traits in Black Slavonian (BS) and "Nero di Parma" (NP) pig breeds analysed according to season

Parity number	Breed	Analysed trait	Farrowing season			
			Spring n=230	Summer n=323	Autumn n=207	Winter n=203
All parities (1st to 11th)	Black Slavonian pig	TNB	6.86±0.14	7.09^{a}±0.12	6.59^{b}±0.15	6.98±0.14
		NBA	6.68^{a}±0.15	6.78^{a}±0.13	6.23^{b}±0.16	6.62±0.16
		NW	5.69^{a}±0.17	6.23^{b}±0.14	6.00±0.18	5.91±0.18
	"Nero di Parma" pig		Spring n=352	Summer n=417	Autumn n=371	Winter n=247
		TNB	7.93^{a}±0.11	8.13^{a}±0.10	8.05^{a}±0.11	7.54^{b}±0.14
		NBA	7.64^{a}±0.12	7.72^{a}±0.11	7.73^{a}±0.12	7.02^{b}±0.15
		NW	6.19^{a}±0.14	6.21^{a}±0.12	6.38^{a}±0.13	5.49^{b}±0.16

TNB – Total Number of Born; NBA – Number of Born Alive; NW – Number of Weaned piglets; n-number of analysed litters per season; LSM±SEwith superscripts (a, b) in the same row between season differ significantly (P<0.05)

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UČINAK SEZONE NA POKAZATELJE VELIČINE LEGLA U CRNE SLAVONSKE PASMINE SVINJA I PASMINE SVINJA“NERO DI PARMA”

Sažetak

Cilj ovog istraživanja bio je analizirati pokazatelje veličine legla u dvije populacije svinja: crne slavonske pasmine svinja (CS) i crne pasmine svinja “Nero di Parma” (NP). Analizirani su pokazatelji veličine legla: ukupan broj oprasenih (UOO), živooprasenih (ŽO) i broj odbijenih odojaka (BOO) od prvog do četvrtog prasenjaza svaku pasminu. Skupnom analizom od prvog do jedanaestog legala prikazani su rezultati UOO, ŽO i BOO po sezoni prasenja.Istraživanjem je bilo obuhvaćeno 296 krmača CS i 421 krmačaNP. Testiranje razlika navedenih pokazatelja od prvog do četvrtog prasenjaprovedenaje analizom varijance s ponovljenim mjerenjima. Podaci skupne analize po sezoni prasenjaprikazani su pomoću općeg linearnog modela izračuna. Statističkom obradom podataka utvrđena je značajna razlika ($p<0,05$) između prvog i trećeg prasenja te prvog i četvrtog prasenja za svojstva UOO i BOO u CS, dok je značajna razlika ($p<0,05$) u broju ŽO ustanovljena samo između prvog i trećeg prasenja. Razlika u broju UOO i ŽO bila je značajna ($p<0,05$) između prvopraskinja u odnosu na treće-i četvrtopraskinje NP. Najmanji BOO u NP zabilježen je u prvopraskinja te su razlike bile značajne ($p<0,05$)u usporedbi s drugim, trećim i četvrtim prasenjem. Skupnom analizom prasenja utvrđene su značajne razlike ($p<0,05$) za UOO između ljetne i jesenske sezone te za ŽO između jesenske i proljetne sezone te jesenske i ljetne sezone prasenja ($p<0,05$). Nadalje, značajna razlika ($p<0,05$) u BOO zabilježena je između proljetne i ljetne sezone prasenja. Broj UOO, ŽO i BOO u NP tijekom zimske sezone bio je značajno manji ($p<0,05$) u odnosu na zabilježene vrijednosti tijekom proljetne, ljetne i jesenke sezone prasenja.

Ključne riječi: sezonalnost, veličina legla, crna slavonska svinja, pasmina “Nero di Parma”.

Primljeno: 21.09.2015.