Analysis of reproduction and litter performance of the Zlotnicka Spotted breed and its different crossbreeds

Karolina Szulc,1 Ewa Słozyczak,1 Anna Panek,1 Damian Knecht,2 Anna Jankowska,3 Zbigniew Sobek,3 Daniel Stanisławski4

1Department of Pig Breeding and Production, the Poznan University of Life Sciences, Poznan, Poland
2Institute of Animal Breeding, Department of Pig Breeding, the Wrocław University of Life Sciences, Wrocław, Poland
3Department of Genetics and Animal Breeding, the Poznan University of Life Sciences, Poznan, Poland
4Computer Laboratory of the Faculty of Animal Biology and Breeding, the Poznan University of Life Sciences, Poznan, Poland

Abstract

Zlotnicka Spotted (ZS) is a native Polish pig breed. It is characterized by low reproduction and litter performance. This study aimed to determine the suitability of ZS pigs when crossed with Duroc and Polish Large White (PLW) breeds, as well as a Duroc x Zlotnicka Spotted (D/ZS) crossbreed. Forty-eight litters were included in the analysis from December 2009 to March 2010.

Introduction

Reproduction and litter performance are very important factors effecting profitability of pig fattening because they determine costs incurred in the production of fatteners (Tyra and Różyczki, 2004). Pigs of the Zlotnicka Spotted breed, like other European native pig breeds, are characterized by relatively low levels of reproduction and litter performance (Barba et al., 2001; Crovetti et al., 2005; Buczyński et al., 2006; Pietrola et al., 2006; Franci and Pugliese, 2007; Serrano et al., 2009). Among all performance traits of pig reproduction, these have the lowest coefficients of heritability (Crump et al., 1997; Knol et al., 2002; Tyra and Różyczki, 2004). This has a considerable impact on effective selection. For this reason, interbreed crossing is commonly used to improve reproduction and litter performance (Pietrola et al., 2006).

The aim of this study was to determine the suitability of Zlotnicka Spotted pigs in crossing with Duroc and Large White Polish based on reproduction and litter performance.

Materials and methods

Animals

The analysis was conducted on a group of Zlotnicka Spotted (ZS) sows mated with boars of Zlotnicka Spotted (control), Duroc (D) and Polish Large White (PLW) breeds, as well as a Duroc x Zlotnicka Spotted (D/ZS) crossbreed. Forty-eight litters were included in the analysis from 4 genetic groups: ZS x ZS, D/ZS x ZS, D x ZS, and PLW x ZS. In each group, 4 litters came from primiparous sows and 8 from multiparous sows. Sows were selected at random. In each genetic group, there were three sire groups (1 boar/4 sows). All boars managed in the herd were used (12 boars). Animals were kept indoors. Feeding and zoohygienic conditions were identical for all animals and consistent with breeding and production standards. Piglets were weaned at seven weeks (49 days) of age. Analyses were carried out from December 2009 to March 2010.

Statistical analysis

Statistical analysis was carried out using the statistical software package SAS 9.1 (2009). The following traits were analyzed: number of piglets in the litter, litter weight, variation coefficient of piglet weight within-litter, and piglet mortality estimated at birth, on the 7th and 21st days of life and at weaning. For these traits, two-way variance analysis was applied taking into consideration effects of the genetic group of the litter and parity order (primiparous vs. multiparous sows) according to the following model:

\[ Y_{ijk} = \mu + r_i + p_j + e_{ijk} \]

where:
- \( Y_{ijk} \) - measured value of the trait,
- \( \mu \) - population mean,
- \( r_i \) - fixed effect of i-th genotype, \( i = 1, 2, 3, 4 \),
- \( p_j \) - fixed effect of j-th parity order (1- primiparous, 2- multiparous),
- \( e_{ijk} \) - effect of random error.

For individual piglet weight and daily weight gains, three-way variance analysis was applied taking into consideration the effect of the genetic group, parity order (primiparous, multiparous) and effect of piglet sex (male, female) according to the following model:

\[ Y_{ijkl} = \mu + r_i + p_j + q_k + e_{ijkl} \]

where:
- \( Y_{ijkl} \) - measured value of the trait,
- \( \mu \) - population mean,
Results and discussion

In Poland, three pig breeds are used in conservative breeding: the Pulawska, the Zlotnicka White and the Zlotnicka Spotted (Krupiński, 2008). Demographic data concerning native breeds are shown in Table 1. In Poland, pigs of native breeds make up only a small percentage of the pig population and are maintained in small herds. It is important to underline that over the last five years, the size of the pig population has been systematically increasing. One exception is the Pulawska breed; a slight decrease in the population size was observed in 2007 and 1,036 females registered in 2009. Reproductive traits in Polish autochthonous pigs over recent years are shown in Table 2. Zlotnicka Spotted sows are characterized by higher litter size than purebred litters. Results confirm data obtained in studies by other authors regarding crossing of Zlotnicka Spotted pigs (Ratajszczak, 1986), as well as other European native breeds (Pietrola et al., 2006; Babicz et al., 2007). The highest number of piglets in the litter at birth was recorded for D/ZS x ZS litters. There was a statistically significant difference (P≤0.01) between these purebred litters and PLW x ZS litters at birth and on the 7th day of life. At weaning, D/ZS x ZS litters were the most numerous but the difference was significant only in respect to ZS x ZS. Piglet wastage is a very important trait. As reported by Knoll et al. (2002), a farmer wants to wean all of his fully

determined the size of purebred Zlotnicka Spotted litters for primiparous sows at 8.1 heads at birth and 7.9 heads on the 21st day of life, while for multiparous sows this was 9.8 and 8.6 piglets, respectively. In their studies, Buczyński et al. (2006) and Szulc et al. (2006) recorded more piglets in their litter at birth than in the present study.

A general trend was observed when comparing litter size in different genetic groups. In all periods of analysis, crossbred litters from D x ZS and D/ZS x ZS groups were characterized by higher litter size than purebred litters. Results confirm data obtained in studies by other authors regarding crossing of Zlotnicka Spotted pigs (Ratajszczak, 1986), as well as other European native breeds (Pietrola et al., 2006; Babicz et al., 2007). The highest number of piglets in the litter at birth was recorded for D/ZS x ZS litters. There was a statistically significant difference (P≤0.01) between these purebred litters and PLW x ZS litters at birth and on the 7th day of life. At weaning, D/ZS x ZS litters were the most numerous but the difference was significant only in respect to ZS x ZS. Piglet wastage is a very important trait. As reported by Knoll et al. (2002), a farmer wants to wean all of his fully


\[ r_k \text{- fixed effect of } k\text{-th genotype, } I = 1, 2, 3, 4, \]
\[ p_j \text{- fixed effect of } j\text{-th parity order (1 - primiparous, 2 - multiparous),} \]
\[ q_k \text{- fixed effect of } k\text{-th piglet sex (1 - male, 2 - female),} \]
\[ e_{ijk} \text{- effect of random error.} \]

For all traits, the significance of differences between the genetic groups was verified using Fisher’s test. For discrete random variables (for number of piglets born alive, on the 7th and 21st day of life), the probit transformation was applied as described by Zuk (1989), making it possible to replace discrete random variables with continuous variables.
formed piglets. When analyzing piglet mortality, the highest piglet wastage was observed in the group ZS x ZS litters. Differences found between groups were statistically significant only for the period from birth to weaning. In this case, the lowest wastage was recorded in the purebred ZS x ZS groups. Low piglet wastage in the Zlotnicka Spotted breed was observed by Ratajczak (1986) and Szulc et al. (2002). During the suckling period, a higher within-litter variation of piglet birth weight was reported for the ZS group than for the D/ZS x ZS. Low piglet wastage in the Zlotnicka Spotted breed was observed by Ratajczak (1986) and Szulc et al. (2002). During the suckling period, a higher within-litter variation of piglet birth weight was reported for the ZS group than for the D/ZS x ZS. The lower weight was probably the consequence of the higher number of piglets in the litter in this genetic group. As observed by Wolf et al. (2008), the selection for higher litter size showed a decrease in the mean piglet birth weight. The lower birth weight increases mortality of piglets in the period of weaning (Milligan et al., 2002; Damagaard et al., 2003). For example, Gondret et al. (2005) reported that light birth-weight pigs were 12 days older at slaughter (at constant weight) than heavy birth-weight pigs. D/ZS x ZS litters were the most numerous and were also the heaviest piglets at birth, despite the fact that individual piglet weights were the lowest (15.82 kg). D x ZS litters were slightly lighter, weighing 15.56 kg. This regularity was not maintained in successive rearing periods analyzed. On the 21st day of life, D x ZS litters were heavier in comparison to ZS x ZS litters. Within-litter variation of piglet weight is very important, especially with regard to birth weight. More deaths were observed in litters with a high variation in birth weight (Milligan et al., 2002; Hermesch, 2001). In our own studies, a higher within-litter variation of piglet birth weight was reported for the ZS x ZS group than for the D/ZS x ZS. Piglet daily weight gain was lower than that reported by other authors (Buczynski et al., 1996). Up to weaning, piglets from the PLW x ZS group had bigger daily weight gains (0.18 kg) than the other litters.

### Conclusions

These results show that the Zlotnicka Spotted breed managed in a pure breeding system is characterized by relatively low parameters concerning reproduction performance. Crossing of ZS sows with D/ZS boars increased the number of piglets born alive in the litter and also the number of piglets weaned in relation to ZS x ZS purebred litters. The lowest number of piglets lost to weaning was observed in PLW x ZS crossbreeding litters. These litters also showed the biggest daily gains in this period. This experiment was conducted on a small number of animals. We intend to repeat it on a larger pig population in the future. This will improve analysis of the results and their interpretation.

### Table 3. Reproduction and litter performance results according to litter genotype.

| Genotype of litter | ZS x ZS | D/ZS x ZS | D x ZS | PLW x ZS |
|--------------------|---------|-----------|--------|---------|
| Number of piglets born alive, head | 8.62^{a} | 10.76^{ab} | 9.21^{b} | 7.98^{a} |
| on the 7th day of age, head | 8.12^{a} | 10.33^{b} | 9.18 | 7.84^{b} |
| on the 21st day of age, head | 8.06^{a} | 9.85^{b} | 8.89 | 7.84^{b} |
| at weaning, head | 7.33^{a} | 8.98^{b} | 8.35 | 7.54 |
| Piglet mortality from birth to the 7th day of age, % | 8.34 | 5.14 | 5.25 | 2.44 |
| to the 21st day of age, % | 9.27 | 5.27 | 9.67 | 2.70 |
| to weaning, % | 17.34^{a} | 16.63^{b} | 7.95 | 2.19 |
| Piglet body weight at birth, kg | 1.55^{a} | 1.47^{b} | 1.68^{a} | 1.53^{a} |
| on the 7th day of age, kg | 2.33^{a} | 2.48^{b} | 2.49^{a} | 2.84^{b} |
| on the 21st day of age, kg | 3.91^{a} | 3.78^{a} | 4.70^{a} | 4.89^{b} |
| at weaning, kg | 9.52^{a} | 7.86^{b} | 9.11^{a} | 9.61^{b} |
| Piglet weight at birth, kg | 13.77 | 15.82^{a} | 15.56^{a} | 12.18^{b} |
| on the 7th day of age, kg | 18.86^{a} | 25.66^{b} | 22.95 | 22.61 |
| on the 21st day of age, kg | 31.49^{a} | 36.40 | 41.87^{b} | 35.42 |
| at weaning, kg | 69.83 | 70.27 | 75.85 | 74.13 |
| Within-litter variation of birth weight, % | 12.31 | 14.13 | 14.03 | 0.06 |
| of 7-day weight, % | 16.68 | 17.98 | 14.86 | 0.07 |
| of 21-day weight, % | 21.22^{a} | 18.79 | 15.56^{a} | 0.14 |
| of weaning weight, % | 21.04 | 19.90 | 19.36 | 0.18 |
| Piglet weight average daily gain | 0.11^{a} | 0.14^{b} | 0.12^{b} | 0.19^{c} |
| to the 7th day of age, kg | 0.11^{a} | 0.11^{b} | 0.14^{a} | 0.14^{b} |
| to weaning, kg | 0.12^{a} | 0.11^{b} | 0.15^{a} | 0.18^{c} |

LSM, least square mean; SE, standard error; ^a,bvalues in rows with different lowercase letters differ significantly (P ≤ 0.05). ^A,Bvalues in rows with different capital letters differ significantly (P ≤ 0.01).
References

Babicz, M., Kasprzyk, A., Stasiak, A., 2007. Analiza efektywności rozrodu loszek i loch rasy paluwańskiej o zróżnicowanych parametrach tucznych i rzeźnych krzytych krzemiennych ras wpb i pbz. Roczn. Nauk. Zoot. Book 2:179-188.

Barba, C., Delgado, J.V., Sereno, J.R.B., Damgaard, L.H., Rydhmer, L., Løvendhal, P., Crump, R.E., Thompson, R., Haley, C.S., Crovetti, A., Bozzi, R., Pugliese, C., Acciaioli, W., Wageningen, The Netherlands. 2009. Pig genetic resources in Europe. Wageningen Pers Publ., Wageningen, The Netherlands.

Buczyński, J.T., Panek, A., Kempisty, B., Szulc, K., Luciński, P., 1997. Origins and development of the Polish Indigenous Złotnicka Spotted Pig. Anim. Sci. Pap. Rep. 24(Suppl.1):35-41.

Buczyński, J.T., Zaborowski, T., Szlandrowicz, S., Gronek, P., 1996. Wartość rozpłodowa loch rasy złotnickiej pstrej przy różnej długoci ich użytkowania. Roczn. AR w Poznaniu, CCLXXIX, Zootech. 48 part II:49-60.

Crovetti, A., Bozzi, R., Pugliese, C., Acciaioli, A., Franci, O., 2005. Genetic parameters of productive traits in Cinta Senese pig. Ital. J. Anim. Sci. 4(Suppl.2):82-84.

Crump, R.E., Thompson, R., Haley, C.S., Mercer, J., 1997. Individual animal model estimates of genetic parameters for reproduction traits of Landrace pigs performance tested in a commercial nucleus herd. Anim. Sci. 65:285-290.

Damgaard, L.H., Rydhmer, L., Løvendhal, P., Grandinson, K., 2003. Genetic parameters for within-litter variation in pig birth weight and change in within-litter variation during suckling. J. Anim. Sci. 81:604-610.

Franci, O., Pugliese, C., 2007. Italian autochthonous pigs: progress reports and research perspectives. Ital. J. Anim. Sci. 6(Suppl.1):663-671.

Gondret, F., Lefaucheur, L., Louveau, L., Lebret, B., Pichodo, X., Le Cozler, Y., 2005. Influence of piglet birth weight on postnatal growth performance, tissue lipogenic capacity and muscle histological traits at market weight. Livest. Prod. Sci. 93:137-146.

Hermesch, S., 2001. Avenues for genetic improvement of litter size and mortality. pp 36-43 in Proc. 7th AGBU Pig Genetics Workshop, Armidale, Australia.

Knap, F., van der Lende, T., Sýkora, M., 2008. Influence of short versus long hyperprolific Czech Large White sows on piglets and losses until weaning. Livest. Prod. Sci. 78:47-55.

Krupiński, J., 2008. Ochrona zasobów genetycznych zwierząt gospodarskich w Polsce. Wiadomości zootechniczne 46:1-10.

Milligan, B.N., Frase, D., Kramer, D.L., 2002. Within-litter birth weight variation in the domestic pig and its relation to pre-weaning survival, weight gain, and variation in weaning weights. Livest. Prod. Sci. 76:181-191.

Pietrola, E., Pilla, F., Maiorano, G., Matassino, D., 2006. Morphological traits, reproductive and productive performance of Casertana pigs reared outdoors. Ital. J. Anim. Sci. 5:139-146.

Ratajczak, M., 1988. Przydatność świń złotnickich do krzyżowania towarowego. Trz. Chlewna. 7:8-9-11.

Ratajczak, M., Buczyński, J.T., 1997. Origins and development of the Polish Indigenous Złotnicka Spotted Pig. Anim. Sci. Pap. Rep. 15:137-148.

SAS, 2009. User’s Guide Statistical Analysis System. SAS Inst. Inc., Cary, NC, USA.

Serrano, M.P., Valencia, D., Fuentetaja, A., Lázaro, R., Mateos, G.G., 2009. Effect of castration on productive performance carcass characteristics meat quality of Iberian pig females reared under intensive management systems. Livest. Sci. 123:147-153.

Szulc, K., Buczyński, J.T., Skrzypczak, E., 2006. Breeding performance of złotnicka spotted sows in pure breeding and in two-breed crossing. Anim. Sci. Pap. 6(Suppl.2):55-59.

Szynider-Nędza, M., Luciński, P., Bajda, Z., 2010. Ochrona zasobów genetycznych świń ras rodzimych – stan hodowli i wyniki oceny. Instytut Zootechniki PIW z. 5:3-24.

Tyra, M., Różycki, M., 2004. Heritability of reproductive traits in pigs. Anim. Sci. Pap. Rep. 22(Suppl.3):235-242.

Ventanas, S., Ventanas, J., Tovar, J., García, C., Estévez, M., 2007. Extensive feeding versus oleic acid and tocopherol enriched mixed diets for the production of Iberian dry-cured hams: effect on chemical composition oxidative status and sensory traits. Meat Sci. 77:246-256.

Wolf, J., Žakova, E., Groeneveld, E., 2008. Within-litter variation of birth weight in hyperprolific Czech Large White sows and its relation to litter size traits, stillborn piglets and losses until weaning. Livest. Sci. 115:195-205.

Zuk, B., 1989. Biometria stosowana – podręcznik. Państwowe Wydawnictwo Naukowe Ed., Warszawa, Poland.