Scientific Annals of Polish Society of Animal Production - Vol. 11 (2015), No 1, 49-57

Influence of body weight and age at first insemination of PIC gilts on the results of reproductive performance and piglet rearing

Karolina Szulc, Ewa Skrzypczak, Janusz T. Buczyński, Tomasz Graczyk

Poznań University of Life Sciences, Faculty of Animal Breeding and Biology,
Department of Pig Breeding and Production,
ul. Wołyńska 33, 60-681 Poznań

The aim of the study was to investigate the influence of body weight and age at first insemination on litter size of and piglet body weight during rearing in PIC hybrid gilts of the Camborough 1080 line. The experiments were carried out on 76 gilts. The gilts were divided into groups according to their body weight and age on the day of their first insemination: gilts of body weight <140 kg (MS I), 140-160 kg (MS II) and >160 kg (MS III); gilts of age <195 days (W I), 195-205 days (W II) and >205 days (W III). Body weight and age were found to significantly affect the results of reproductive performance and rearing of piglets. Piglets born from gilts with the highest body weight (MS III) had significantly higher (P≤0.01) daily weight gain throughout their rearing period and attained the highest body weight. The largest litter size was noted in the gilts that were inseminated latest (W III). On average they bred and reared over two more piglets than gilts that were inseminated early (W I). The results indicate that in order to obtain high reproduction results in PIC gilts, their reproductive performance should begin at the age of at least 205 days and when they weigh no less than 140 kg.

KEY WORDS: gilts / reproduction / body weight / age

Reproductive traits, which are crucial for the economic efficiency of pig production, depend on numerous environmental and genetic factors [1, 2, 13, 17]. Due to the many elements determining the level of reproductive traits and to their low heritability, significant improvement of reproductive performance is difficult. Important factors influencing reproductive parameters include fattening and carcass performance characteristics and body weight and age at the time of the first artificial insemination or mating [1, 15, 18, 19, 20, 21]. Owing to the increasing growth rate observed in pigs, they are beginning to reproduce at a younger and younger age. This applies in particular to crossbreeds and hybrid lines. Many authors have attempted to analyse the effect of the body weight and age of gilts beginning their reproductive performance on their reproductive parameters, as this is an important question not only for scientific knowledge, but in practice as well [8, 10, 11, 14, 15, 19, 20]. This is particularly true now, when hybrid and crossbred animals constitute

a large proportion of the sow population worldwide and in Poland. However, research results have thus far been inconclusive. Tummaruk et al. [19, 20] and Patterson et al. [11] found that the body weight and age of sows had a significant effect on the number of piglets in the litter. Similar results were obtained by Kummer et al. [8] and by Vidović et al. [21]. In contrast, Mucha et al. [10] and Rekiel and Więcek [12] found no significant effect of the body weight of gilts at first mating on indicators of reproductive performance. Roongsitthichai et al. [14] noted no significant effect of the body weight and age of gilts during their first artificial insemination on the size of their first litters, but these factors were found to affect the size of the second and later litters. Saito et al. [15] reported that the age of gilts at first mating influenced the length of their reproductive life.

The aim of the study was to analyse the effect of the body weight and age of PIC gilts of the Camborough 1080 line at their first artificial insemination on their reproductive performance and rearing of the piglets, including litter size, litter weight, and piglet body weight during rearing, from birth to weaning.

Table 1
Composition of mixtures

Specification	Mixture for gilts	Mixture for pregnant sows	Mixture for suckling sows
Crude protein (g/kg)	154	124	170
Metabolic energy (MJ/kg)	12.8	11.9	13.0
Barley (%)	43.5	39.75	30.0
Wheat (%)	30.0	18.0	32.75
Maize (%)	10.0	10.0	10.0
Wheat bran (%)	–	25.0	2.5
Soybean meal (%)	14.0	3.0	19.0
Soybean oil (%)	–	1.0	2.0
Protein concentrate (%)	2.5	–	–
Protein concentrate (%)	–	3.0	–
Protein concentrate (%)	–	–	3.5
Mycotoxin absorber (%)	–	0.25	0.25

Material and methods

The material for the study consisted of 76 PIC gilts of the Camborough 1080 hybrid line. On the day of their first insemination the gilts were weighed and their age was determined. The pigs were divided into groups according to their body weight at first insemination: <140 kg (MS I), 140-160 kg (MS II) and >160 kg (MS III). Age groups were distinguished as well: gilts aged <195 days (W I), 195-205 days (W II), and >205 days (W III).

All female pigs were housed in identical conditions and fed according to current standards. The composition of the compound feed in each stage of the production cycle is presented in Table 1. The gilts were artificially inseminated with semen from a PIC line 410 boar. Insemination was performed during the second oestrus, and the procedure was the same for all gilts.

The following traits of the first litters were analysed: number of live-born and stillborn piglets, number of mummified foetuses in the litter, number of weaned piglets per litter, and piglet body weight and litter weight at birth and at weaning. In addition, the mean daily weight gains of the piglets and the litter were determined for the rearing period from birth to weaning at 28 days of age.

After birth the piglets were dried off, the umbilical cords were disinfected, the needle teeth were ground down with an electric grinder, the tails were docked with a gas-heated docking iron, and the piglets were injected with an antibiotic to protect against infection. The male piglets were castrated at the age of three days. On the same day all piglets received the iron preparation Ferran 200 in the form of an injection.

To determine the effect of the body weight and age of the gilts at their first insemination on the results of their reproductive performance and rearing of the piglets, two-way analysis of variance was performed, according to the following formula:

$$y_{ijk} = \mu + m_i + w_j + e_{ijk}$$

where:

y_{ijk} – value of the characteristic for the *ijk*-th individual (gilt)

μ – grand mean

m_i – fixed effect of the *i*-th range of gilt body weight at insemination ($i = 1, 2, 3$), where: 1 – body weight <140 kg, 2 – body weight 140-160 kg, 3 – body weight >160 kg

w_j – fixed effect of the *j*-th range of gilt age at insemination ($j = 1, 2, 3$), where: 1 – age <195 days, 2 – age 195-205 days, 3 – age >205 days

e_{ijk} – random error

For the groups obtained by dividing the study material according to the factors included in the analysis of variance, a least significant difference (LSD) test was performed for pairs of means. Statistical computations were performed using the PROC GLM and MEANS LSD procedures of the SAS statistical package [16].

Results and discussion

Matysiak et al. [9], in a study on crossbred gilts, showed that in attempting to improve reproductive efficiency we should monitor body weight and age at the time of the first mating or artificial insemination. Kiernerová et al. [6] have also suggested that first mating of gilts at a body weight of 125-145 kg maintains them in good condition during their reproductive life.

In the present study, the body weight of the gilts at first insemination had a significant ($P \leq 0.01$) effect on piglet body weight at weaning and on average daily gains in the piglets from birth to weaning (Tab. 2). The body weight of the gilts was not found to significantly influence the size of the first litters. However, the gilts in group MS II (140-160 kg) showed a tendency to give birth to and rear the largest litters and to produce the fewest mummified foetuses. Similar observations were made by Roongsitthichai et al. for Landrace x Yorkshire gilts [14]. Mucha et al. [10] also found no significant effect of gilt body weight at first mating on litter size. However, as in the present study, the

Table 2

Results of reproduction performance and rearing depending on the body weight of gilts on the day of their first insemination

Trait	Body weight of gilts		
	MS I n = 28	MS II n = 26	MS III n = 22
Piglets born alive	10.89 ±2.69	11.97 ±2.12	10.75 ±3.38
Stillborn piglets	0.89 ±0.96	0.63 ±0.80	1.33 ±2.26
Mummified piglets	0.28 ±0.57	0.12 ±0.34	0.25 ±0.45
Piglets weaned	10.78 ±2.64	11.75 ±2.01	10.58 ±3.31
Piglet birth weight (kg)	1.31 ±0.21	1.24 ±0.16	1.37 ±0.18
Piglet weaning weight (kg)	7.02^{A} ±0.84	7.30^{AB} ±1.02	8.50^{B} ±1.77
Daily weight gain of piglet during rearing period (g)	194^{A} ±21	216^{A} ±34	249^{B} ±45
Litter weight at birth (kg)	13.97 ±3.26	14.49 ±2.13	14.40 ±4.45
Litter weight at weaning (kg)	75.22 ±19.11	85.73 ±18.40	86.23 ±23.81
Daily weight gain of litter during rearing period (g)	2082^{a} ±512	2522^{b} ±537	25331^{b} ±710

MS I – body weight of gilts <140 kg, MS II – body weight of gilts 140-160 kg, MS III – body weight of gilts >160 kg
a, b – values in rows with different letters differ significantly at $P \leq 0.05$
A, B – values in rows with different letters differ significantly at $P \leq 0.01$

authors observed a tendency towards a greater number of born and reared piglets in the litters of females with greater body weight at first mating. Foxcrof et al. [3] and Williams et al. [23] found that body weight at first insemination or mating is an important factor determining litter size.

PIC guidelines for raising gilts for breeding suggest that the optimal mating time for young hybrid females is the second oestrus or later; their body weight should be over 130-140 kg and they should have reached the age of 220-240 days [4]. In the present study the lowest body weight at weaning was noted for the piglets from the MS I females (<140 kg). The piglets in this group also had low daily weight gains during the period from birth to weaning. In this respect they differed significantly from the piglets of the MS III gilts. Matysiak et al. [9] reported a significant correlation (0.234) between the mean body weight of piglets at 21 days of age and the body weight of gilts at first mating. Vouzela et al. [22], in an analysis of the body weight of female pigs at the start of their use for breeding on reproductive and piglet rearing characteristics, found a significantly higher litter weight at 28 days of age for the group of gilts with the highest mean body weight (147.20 kg) as compared to the litters of females with lower body weight (127.50 kg). Mucha et al. [10] observed that litters of gilts with higher body weight at mating (152.41 kg) weighed more than litters obtained from females with lower body weight (123.73 kg). These differences, however, were not statistically significant.

In the present study, gilt body weight at first insemination was found to significantly ($P \leq 0.05$) affect the daily litter weight gain during the rearing period. The lowest gains were noted for the MS I litters, as compared to the MS II and MS III litters. This was due to the higher individual weight gain in the piglets in group MS III and the statistically non-significant, but larger mean litter size for group MS II.

The age of the female influences the development of the reproductive system [5]. Thus it is important that the use of gilts for breeding should begin after growth and development are complete. This enables maximum bone mineralization and accumulation of body reserves [7]. Mating of very young gilts with low body weight may disrupt this process and have a negative effect on their fertility. This is confirmed by results presented by Vidović et al. [21]. The authors, evaluating the effect of the weight and age of Landrace gilts at their first insemination on litter size, obtained the best results in the oldest group of gilts (231-260 day), with the highest body weight (131-170 kg). The analysis of variance performed in the present study revealed that the age of the gilts at first insemination influenced the number of live-born and stillborn piglets per litter, the number of weaned piglets per litter, and litter weight at birth, as well as the daily litter weight gain from birth to weaning (Tab. 3).

Older gilts, inseminated at the age of over 205 days (W III), gave birth to and reared significantly ($P \leq 0.05$) more piglets in their first litter than gilts inseminated at under 195 days of age (W I). This result differed from those obtained in a study on PIC gilts conducted by Kummer et al. [8]. These researchers observed that first mating of gilts at the age of 185-210 days, with a body weight of at least 127 kg, had

Table 3
Results of reproduction performance and rearing depending on the age of gilts on the day of their first insemination

Trait	Age of gilts		
	W I n = 23	W II n = 22	W III n = 31
Piglets born alive	9.92^{a} ±2.87	10.75^{ab} ±2.77	12.50^{b} ±2.34
Stillborn piglets	1.15^{a} ±1.34	0.83^{a} ±0.84	0.44^{b} ±0.89
Mummified piglets	0.31 ±0.63	0.17 ±0.39	0.18 ±0.40
Piglets weaned	9.89^{a} ±2.85	10.58^{ab} ±2.68	12.25^{b} ±2.29
Piglet birth weight (kg)	1.35 ±0.21	1.27 ±0.22	1.25 ±0.16
Piglet weaning weight (kg)	7.67 ±1.53	7.25 ±1.46	7.51 ±1.14
Daily weight gain of piglet during rearing period (g)	219 ±52	208 ±34	217 ±34
Litter weight at birth (kg)	12.98^{a} ±3.08	13.32^{ab} ±3.25	15.44^{b} ±2.86
Litter weight at weaning (kg)	73.63 ±19.78	74.80 ±15.91	91.62 ±20.51
Daily weight gain of litter during rearing period (g)	2084^{a} ±513	2153^{ab} ±459	2647^{b} ±682

W I – age of gilts <195 days, W II – age of gilts 195-205 days, W III – age of gilts >205 days
a, b – values in rows with different letters differ significantly at P≤0.05
A, B – values in rows with different letters differ significantly at P≤0.01

no effect on reproductive outcomes in the first three cycles. Tummaruk et al. [20] showed that the physiological norm for the age and body weight at which Landrace x Yorkshire gilts achieve sexual maturity is about 195 days and 106 kg. In practice it is recommended not to begin breeding gilts until the second oestrus, at a mean body weight of 130 kg.

To sum up, the body weight of gilts during their first insemination significantly affected the results of piglet rearing, including piglet body weight at weaning and mean daily piglet and litter weight gains during rearing. The age of the gilts significantly influenced both reproductive performance and rearing results. Piglets born to gilts inseminated at the highest body weight had significantly higher daily weight gains during rearing and attained the greatest body weight at weaning. The age of the gilts also had a significant effect on litter size at birth and at weaning, as well as on the number of stillborn piglets per litter and litter weight gain from birth to weaning. The largest litters were born to

gilts inseminated at the age of over 205 days (W III), and thus the oldest. They gave birth to and reared on average over two more piglets than gilts inseminated at the age of under 195 days (W I). The results obtained indicate that in the case of PIC gilts, to obtain good reproductive results it is beneficial to begin breeding at the age of at least 205 days and at a body weight of no less than 140 kg. Due to the small number of gilts evaluated and the fact that only first litters were considered in the study, further analyses including subsequent productive cycles are necessary. This would make it possible to verify breeding guidelines and to determine the optimum body weight and age at which reproductive use of PIC gilts should begin. This in turn will improve the profitability of pig production in herds of PIC gilts.

REFERENCES

1. AMARAL FILHA W.S., BERNARDI M.L., WENTZ I., BORTOLOZZO F., 2010 – Reproductive performance of gilts according to growth rate and thickness at mating. ***Animal Reproduction Science*** 121, 139-144.
2. COOLS A., MAES D., DECALUWÉ R., BUYSE J., VAN KEMOEN T.A.T.G., LIESEGANG A., JANSSENS G.P.J., 2014 – Ad libitum feeding during the periprenatal period affects body condition, reproduction results and metabolism of sows. ***Animal Reproduction Science*** 145, 130-140.
3. FOXCROFT G.R., 2002 – Nutrição, crescimento e condicionamento de leitoas para a vida productive. In: Proceeding of I Congresso Latino-Americano de suinocultura, Foz do Iguaçu, Paraná, Brazil, 14-24.
4. INFORMATOR PIC, 2011 – Podstawy wprowadzania i utrzymywania loszek hodowlanych. Kwartalnik 12, 8-10.
5. KAPELAŃSKI W., JANKOWIAK H., BOCIAN M., GRAJEWSKA S., DYBAŁA J., ŻMUDZIŃSKA A., 2013 – Morphometric characteristics of the reproductive system in Polish Large White and Polish Landrace gilts at 100 kg body weight. ***Annals of Animal Science*** 13, 1, 45-53.
6. KIERNEROVÁ N., VÁCLAVOVSKÝ J., MATOUŠEK V., HANYKOVÁ Z., 2006 – The use of performance test parameters for selection of gilts and their subsequent reproductive performance. ***Annals of Animal Science*** 9, 3, 253-261.
7. KIRKWOOD R.N., THACKER P.A, 1992 – Management of replacement breeding animals. ***The Veterinary Clinics of North America: Food Animal Practice*** 8, 575-587.
8. KUMMER R., BERNARDI M.L., WENTZ I., BORTOLOZZO P.F., 2006 – Reproductive performance of high growth rate gilts inseminated at an early age. ***Animal Reproduction Science*** 96, 47-53.
9. MATYSIAK B., KAWĘCKA M., JACYNO E., KOŁODZIEJ-SKALSKA A., PIETRUSZKA A., 2010 – Parametry oceny loszek przed pierwszym pokryciem, a wyniki ich użytkowości rozpłodowej. ***Acta Scientiorum Polonorum***, ***Zootechnica*** 9, 2, 29-38.

10. MUCHA A., TYRA M., SZYNDLER-NĘDZA M., ORZECHOWSKA B., 2011 – Wpływ wieku i masy ciała loszek w dniu pierwszego krycia na ich późniejszą użytkowość rozpłodową. ***Roczniki Naukowe Zootechniki*** 38, 2, 205-218.
11. PATTERSON J.L., BELTRANENA E., FOXCROFT G.R., 2010 – The effect of gilt age at first estrus and breeding on third estrus on sow body weight changes and long-term reproductive performance. ***Journal Animal Science*** 88, 2500-2513.
12. REKIEL A., WIĘCEK J., 2002 – Wpływ otłuszczenia, umięśnienia i masy ciała loszek przy pierwszym kryciu na ich dalszą użytkowość rozpłodową. ***Prace i Materiały Zootechniczne***, Zeszyt Specjalny, 13, 131-138.
13. REKIEL A., WIĘCEK J., BEYGA K., 2011 – Analysis of the relationship between fitness of late pregnant and lactating selected sows and lipid parameters of blood, colostrum and milk. ***Annals of Animal Science*** 11, 485-493.
14. ROONGSITTHICHAI A., CHEUCHUCHART P., CHATWIJITKUL S., CHANTAROTHAI O., 2013 – Influence of age at first estrus, body weight, and average daily gain of replacement gilts on their subsequent reproductive performance as sows. ***Livestock Science*** 151, 238-245.
15. SAITO H., SASAKI Y., KOKETSU Y., 2011 – Associations between age of gilts at first mating and lifetime performance or culling risk in commercial herds. ***The Journal of Veterinary Medical Science*** 73, 5, 555-559.
16. SAS, 2011 – User's Guide. Statistical Analysis System Institute, Inc. Cary North California.
17. SZYNDLER-NĘDZA M., RÓŻYCKI M., ECKERT R., MUCHA A., KOSKA M., SZULC T., 2013 – Relationships between chemical composition of colostrum and milk and rearing performance of piglets during a 21-day lactation. ***Annals of Animal Science*** 13, 4, 771-781.
18. SZULC K., KNECHT D., JANKOWSKA-MĄKOSA A., SKRZYPCZAK E., NOWACZEWSKI S., 2013 – The influence of fattening and slaughter traits on reproduction in Polish Large White sows. ***Italian Journal of Animal Science*** 12, 16-20.
19. TUMMARUK P., LUNDEHEIM N., EINARSSON S., DALIN A.M., 2001 – Effect of birth litter size, birth parity number, growth rate, backfat thickness and age at first mating of gilts on their reproductive performance as sows. ***Animal Reproduction Science*** 66, 225-237.
20. TUMMARUK P., TANTASUPARUK W., TECHAKUMPHU M., KUNAVONGKRIT A., 2007 – Age, body weight and backfat thickness at first observed oestrus in crossbred Landrace x Yorkshire gilts, seasonal variations and their influence on subsequence reproductive performance. ***Animal Reproduction Science*** 99, 167-181.
21. VIDOVIĆ V., ŠTRABAC Lj., LUKAČ D., STUPAR M., 2011 – Influence of age and weight of Landrace gilts at fertile insemination on litter size and longevity. ***Biotechnology Animal Husbandry*** 27, 1, 75-84.

22. VOUZELA C.F.M., FERRERIRA G., ROSA H.J.D., REGO O.A., BORBA A.E.S., 2009 – Effect of live weight at first breeding on reproductive and productive performance of gilts. EAAP, Books of Abstracts, Spain, Barcelona, 450.
23. WILLIAMS N., PETTERSON J., FOXCROFT G., 2005 – Non-negotiables in gilt development. ***Advances in Pork Production*** 16, 281-289.