Original Paper

The Effect of Gender, Growth rate and Sire Line on Live Pigs Performance

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The aim of the study was to evaluate the effect of gender, growth rate and different sire lines on live weight, average daily gain (ADG), back fat thickness and lean meat content in the breed Large White. The study evaluated 232 pigs, of which 201 were gilts and 31 were boars. Data were collected using a Piglog 105 apparatus, which was used to measure lean meat content, back fat thickness and average daily gain. Back fat thickness was significantly higher in gilts (0.933 ±0.01 cm) than in boars (0.806 ±0.02 cm), (P <0.001). Pigs with the highest growth rate – average daily gains had significantly lower back fat thickness (0.847 ±0.01 cm) and a higher lean meat content (62.702 ±0.11%, P <0.001) than pigs with lower gains. The results showed that sire line had a significant effect on ADG of the pigs evaluated (P <0.001), with the highest ADG recorded in sire line A (669.6 ±10.34 g.day^{-1}) and the lowest in sire line C (612.77 ±4.24 g.day^{-1}). There were no significant differences (P >0.05) in back fat thickness and lean meat content between the lines. The results of the study indicate that for increasing the lean meat content in pigs, breeding animals with high growth intensity should be selected.

Keywords: pigs, lean meat content, back fat thickness, growth rate

1 Introduction

Pig farming has a long tradition in Slovakia and pork consumption accounts for about half of total consumption. Pig performance represented by daily gain, feed conversion and carcass characteristics is influenced by several factors such as gender, genetic line, growth rate, breed, feed quality, etc. (Mlynek et al., 2023). Scientific studies show that males generally have higher growth intensity and better feed conversion than females (Morenikeji et al., 2019). At the same time, barrows have higher feed consumption per kg gain and higher back fat thickness than gilts and boars (Piao et al., 2004; Latorre et al., 2008a; Sheikh et al., 2017). Gilts exhibit a higher proportion of lean meat content and greater *Musculus longissimus dorsi* area compared to barrows (Piao et al., 2004; Sheikh et al., 2017). Differences between the genders become more pronounced as pig weight increases (Andersson et al., 2005). Growth intensity is closely related to the proportion of each tissue in the pig body – there is a negative correlation between average daily gain (ADG) and lean meat content (LMC), highlighting the need to optimise these traits in breeding programmes (Stege et al., 2011). With increasing slaughter weight, there is an increase in back fat thickness and a decrease in the proportion of muscle tissue in the carcass (Sládek et al., 2004). In addition to the above factors, pig performance also depends on breed, e.g. the Duroc breed is known to have a higher intramuscular fat content and better sensory meat quality (Latorre et al., 2009; Lowell et al., 2019), while the Pietrain breed is characterized by a higher proportion of lean meat content (Lowell et al., 2019). An important factor within a particular breed is the choice of sire line. In commercial settings, where the maternal family is largely fixed, artificial insemination allows for flexible sire selection (Elbert et al., 2020). Sire line strongly influences the growth rate of muscle and back fat, indicating differences in growth intensity of pigs (Schinckel et al., 2009) and directly affecting carcass and quality parameters (Latorre et al., 2003; Gilleland et al., 2019). Based on the above information,the aim of this study was to evaluate the effect of sex, growth intensity and sire line on live pig performance.

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2 Material and Methods

2.1 Biological Material

In the experiment, 232 pigs (201 gilts and 31 boars) of the Large White breed, weighing between 84 kg and 120 kg live weight, were evaluated. The pigs' performance was evaluated from 2021 to 2024 on a local farm in Slovakia.

2.2 Housing and Feeding of Pigs

The evaluated pigs were housed in the same conditions and reared on the same complete pig feed mixture for growing gilts and boars. The floor in the housing was concrete straw bedded, with daily excreta removal. The pigs were fed using an automatic dry feeding line, using a complete feed mixture in pelleted form. The pigs were fed using *ad libitum* nipple drinkers. The housing of the pigs met the minimum requirements according to EU Directive 2008/120/EC (Council Directive, 2008).

2.3 Evaluated Parameters

In the experiment, on the day of the pigs' performance tests, the following parameters were evaluated: weight (accurate to 1 kg), age (days), average daily gain (g.day-1), back fat thickness (cm) and lean meat content (%). The average daily gain, back fat thickness and lean meat content determined on the day of measurement were converted to 100 kg live weight using the equations below. The back fat thickness and lean meat content were measured using a Piglog 105 (SFK Technology A/S, Denmark) (User's Manual Slovakia, 2006). During the measurement, the pigs had to stand in a horizontal measuring pen on a solid floor with a firm support on the fore and hind limbs and the head in a horizontal position.

Three measurement points, designated M1, M2 and M3, were established for the measurement of back fat thickness using the Piglog 105 instrument. These points were located on a straight line 5 to 6 cm from the anatomical reference points A0, B0 and C0 on the left side of the animal's back. Measurement point M1 was located midway between the transferred points A0 and B0. Point M2 was located midway between point M1 and point B0. Measurement point M3 was located midway between points B0 and C0 (Figure1).

Measurement points M1 (measured back fat thickness) and M2M3 (measured back fat thickness and depth of the *Musculus longissimus dorsi*) were used to determine the proportion of muscle, which lay on a straight line 7 cm away from points A0, B0 and C0 on the left side of the back. Point M1 was located between the third and fourth lumbar vertebrae. Point M2M3 was located between the third and fourth ribs (Figure 2).

Average daily gain (ADG), back fat thickness (BFT) and lean meat content (LMC) were converted per 100 kg live weight using the following equations (Řeháček et al., 2001):

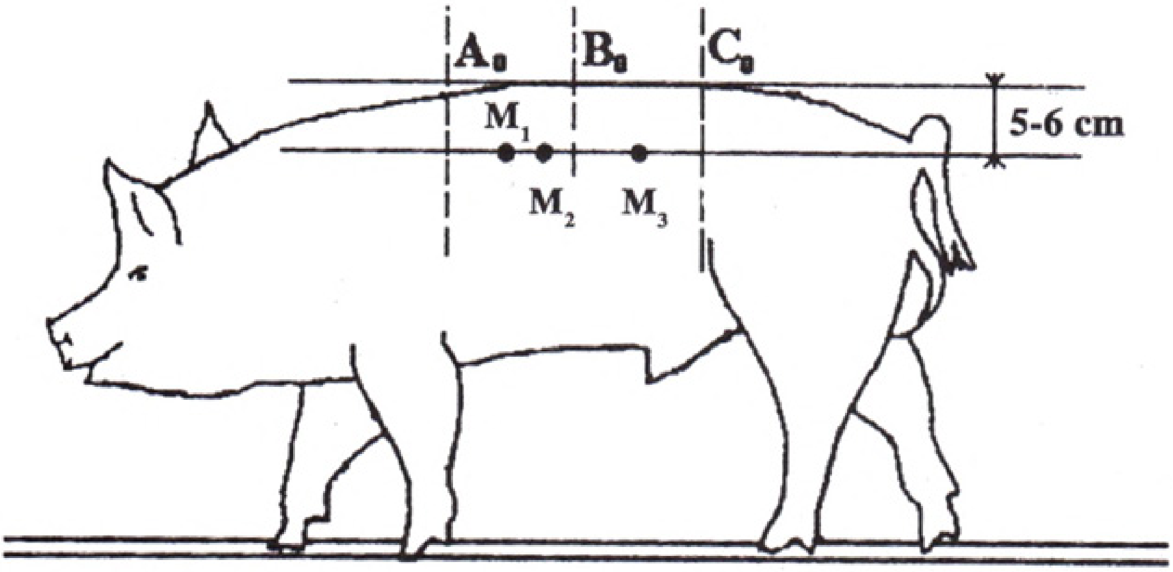

Figure 1 Back fat thickness measurement points
Source: Řeháček et al., 2001

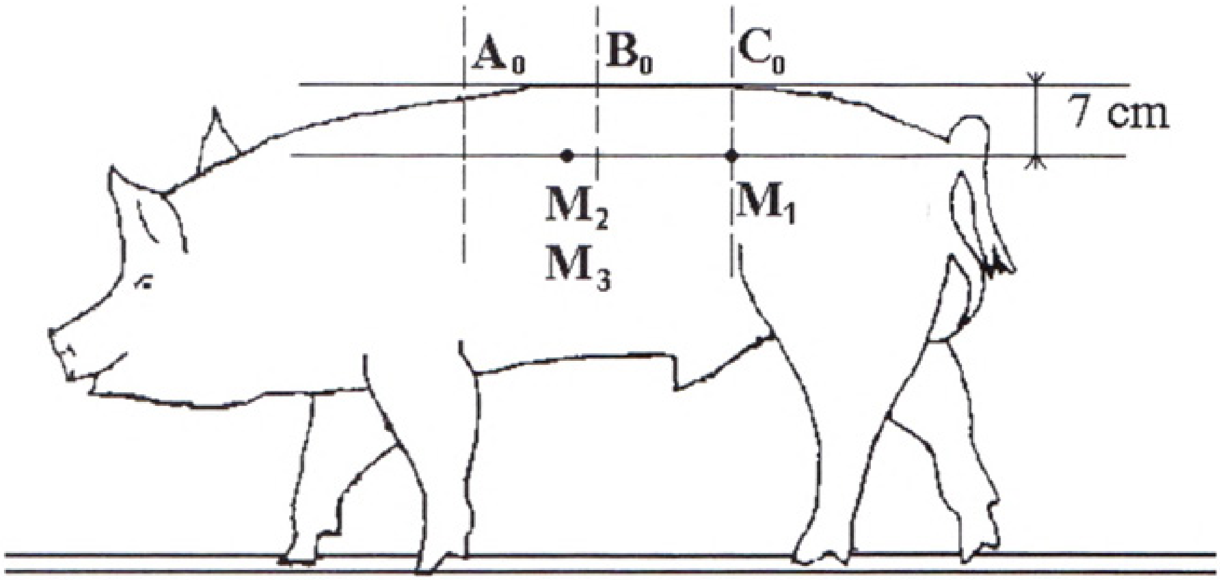

Figure 2 Measurement points for the lean meat content
Source: Řeháček et al., 2001

Converted average daily gain on 100 kg live weight (ADG_{100}):

$$ADG_{100} = K[-1(W - 100)] + ADG$$

where: K – gender conversion coefficient (2.58 gilt and 2.26 boar); W – weight on the day of measurement; ADG – average daily gain on the day of measurement.

Converted back fat thickness on 100 kg live weight (BFT_{100}):

$$BFT_{100} = K[-1(W - 100)] + BFT$$

where: K – gender conversion coefficient (0.017 gilt a 0.012 boar); W – weight on the day of measurement; BFT – average back fat thickness on the day of measurement

Converted lean meat content on 100 kg live weight (LMC_{100}):

$$LMC_{100} = LMC + b(W - 100)$$

where: b – gender conversion coefficient (0.0859 gilt a 0.0894 boar); LMC – lean meat content in % on the day of measurement; W – weight on the day of measurement (kg)

2.4 Statistical Analysis

The results obtained were analysed using IBM SPSS Statistics 20 Program. Comparisons between groups were performed using one-factor ANOVA analysis of variance, with testing of contrasts using Scheffe's test at a significance level of $P < 0.05$.

The influence of monitored parameters was tested with the following model equations:

Effect of gender:

$$y_{ij} = \mu + g_i + \varepsilon_{ij}$$

where: y_{ij} – respected dependent variable; μ – intercept; g_i – effect of the gender i ($i = 1$: gilt, $i = 2$: boar); ε_{ij} – residual error

Effect of growth intensity:

$$y_{ij} = \mu + g_{ri} + \varepsilon_{ij}$$

where: y_{ij} – respected dependent variable; μ – intercept; g_{ri} – effect of the growth intensity i ($i = 1$: ADG1 (545–611 g.day^{-1}), $i = 2$: ADG2 (612–688 g.day^{-1}), $i = 3$: ADG3 (690–799 g.day^{-1})), ε_{ij} – residual error

To assess the effect of growth intensity, pigs were divided into 3 groups using a quartile distribution based on the converted average daily gain on the day of measurement; ADG1: 545–611 g.day^{-1}, ADG2: 612–688 g.day^{-1} and ADG3: 690–799 g.day^{-1} ($n = 58$).

$$y_{ij} = \mu + s_{ri} + \varepsilon_{ij}$$

where: y_{ij} – respected dependent variable; μ – intercept; s_{ri} – effect of the sire line i ($i = 1$: A, $i = 2$: B, $i = 3$: C, $i = 4$: D, $i = 5$: E), ε_{ij} – residual error

In the experiment, following sire lines were evaluated: 2789 (A), 2884 (B), 2886 (C), 2991 (D) a 2993 (E). The boars of the evaluated sire lines were purebred Large white breed.

3 Results and Discussion

Table 1 shows the results of the performance parameters by gender. The weights of boars and gilts were similar on the day of performance evaluation (110.55 ±8.58 kg vs. 109.2 ±8.89 kg, *P* >0.05), but gilts had a significantly higher age (170.35 ±14.66 days) than boars (156.90 ±8.26 days) (*P* <0.001). Other authors have also found that there are differences in live weight at the same age or differences in age at similar weight between the genders. Elbert et al. (2020) detected significantly higher weight at the same age in boars than gilts (*P* <0.001). Similarly, Oh et al. (2022) showed significantly lower age at the same weight in boars than in gilts (*P* <0.001). Serrano et al. (2008) found higher weights in boars compared to gilts, but the differences were not significantly. This suggests that sows reach boar weight at a later age.

Higher converted ADG_{100} was recorded in boars, 682.74 ±8.27 g.day^{-1} than in gilts 619.27 ±3.14 g.day^{-1} (*P* <0.001) (Table 1). Also, Lego and Bondoc (2020) and Liu et al. (2021) reported higher ADG in boars than in gilts. Blanchard et al. (1999) confirmed that boars had higher ADG than gilts (*P* <0.001). Sheikh et al. (2017) showed inconclusive differences between gender and gain, with boars having higher ADG than barrows, and the lowest ADG was for gilts. These results suggest that boars achieve higher ADG and that hybrid breed combinations achieved higher ADG than the Large White breed.

A higher mean converted back fat thickness per 100 kg live weight (BFT_{100}) was measured in gilts (0.933 ±0.01 cm) than in boars (0.806 ±0.02 cm), this difference was statistically significant (*P* <0.001), (Table 1). Other authors have also evaluated the effect of gender on back fat thickness. Dunshea (2005), Aymerich et al. (2019) measured significantly higher back fat thickness in gilts than in boars (*P* <0.001). In contrast, Correa et al. (2008) measured higher back fat thickness in boars than in gilts, but this result was not statistically significant (*P* >0.05). The available literature suggests that gilts achieve higher back fat thickness than boars.

When evaluating the effect of gender on the lean meat content (Table1) at 100 kg live weight (LMC_{100}), we detected that boars had a higher lean meat content (63.148 ±0.17%) than gilts (62.033 ±0.05%) (*P* <0.001). Aymerich et al. (2019), showed a significantly lower proportion of lean meat content in gilts than in boars (*P* <0.001). Correa (2006) and Bahelka et al. (2007) found a higher proportion of lean meat content in gilts than in barrows (*P* <0.05). Xia et al. (2022) although found that gilts had a higher proportion of lean meat content than castrated males, but the difference was not statistically significant (*P* >0.05).

Table 2 shows the effect of growth intensity on the pig performance indicators. The highest mean age was observed in the ADG1 group (178.2±14.89 days). As growth intensity increased, the mean age of pigs decreased, with a mean age of 158.71 ±9.70 days in group ADG3. There was a statistically significant difference between growth intensity and age (*P* <0.001). Significantly the lowest mean weight was detected in ADG1 group (104.70 ±9.17 kg), and significantly the highest pig weight was found in ADG3 group (114.67 ±6.22 kg) (*P* <0.05).

The highest BFT_{100} was in the ADG1 group (0.978 ±0.03 cm) (Table 2). As growth intensity increased, back fat thickness decreased, with the group of pigs with the highest growth intensity (ADG3) having significantly the lowest back fat thickness (0.847 ±0.01 cm, *P* <0.001). In contrast to our findings, several authors found an opposite effect of growth intensity on back fat thickness. Gallo et al. (2017) measured the highest back fat thickness in the group of pigs with the highest daily gains (*P* <0.001). Similarly, Orzechowska et al. (2010) found greater back fat thickness in pigs with higher daily gain, but the differences they observed were not statistically significant (*P* >0.05).

The proportion of lean meat content increased with increasing growth intensity (Table 2). Significantly, the lowest proportion of LMC_{100} was recorded in ADG1

Table 1 Effect of gender on pig performance

Gender	Gilts ($\bar{x}$ ±SD) (*n* = 201)	Boars ($\bar{x}$ ±SD) (*n* = 31)	*P*-value
Age (day)	170.35 ±14.66	156.90 ±8.26	*P* <0.001
Weight (kg)	109.2 ±8.89	110.55 ±8.58	NS
ADG_{100} (g.day^{-1})	619.27 ±3.14	682.74 ±8.27	*P* <0.001
BFT_{100} (cm)	0.933 ±0.01	0.806 ±0.02	*P* <0.001
LMC_{100} (%)	62.033 ±0.05	63.148 ±0.17	*P* <0.001

ADG_{100} – average daily gain on 100 kg live weight; BFT_{100} – back fat thickness on 100 kg live weight; LMC_{100} – lean meat content on 100 kg live weight; SD – standart deviation; x̄ – mean; NS – not significant

Table 2 Effect of growth intensity on pig performance

Growth rate	ADG1 ($\bar{x}$ ±SD) (*n* = 60)	ADG2 ($\bar{x}$ ±SD) (*n* = 115)	ADG3 ($\bar{x}$ ±SD) (*n* = 58)	*P*-value
Age (day)	178.2 ±14.89^{a}	168.49 ±14.30^{b}	158.71 ±9.70^{c}	*P* <0.001
Weight (kg)	104.70 ±9.17^{a}	109.15 ±8.40^{b}	114.67 ±6.22^{c}	*P* <0.001
BFT_{100} (cm)	0.978 ±0.03^{b}	0.919 ±0.01^{b}	0.847 ±0.01^{a}	*P* <0.001
LMC_{100} (%)	61.85 ±0.10^{a}	62.092 ±0.06^{a}	62.702 ±0.11^{b}	*P* <0.001

ADG1 – 545–611 g.day^{-1}; ADG2: 612–688 g.day^{-1}; ADG3: 690–799 g.day^{-1}; BFT_{100} – back fat thickness on 100 kg live weight; LMC_{100} – lean meat content on 100 kg live weight; SD – standard deviation; $\bar{x}$ – mean; a, b, c – different letters in the same row indicate significant differences among the mean values (*P* <0.05)

group (61.85 ±0.10%), and the proportion of lean meat content was significantly highest in ADG3 group (62.702 ±0.11%, *P* <0.05). A similar effect of higher growth intensity on the greater proportion of lean meat content in pigs has been reported by other authors (Orzechowska et al., 2010; Gallo et al., 2017). In contrast to these findings, Affentranger et al. (1996) reported that pigs with lower feed intake have lower gains, less subcutaneous fat and a higher proportion of lean meat content.

Table 3 shows the effect of sire line on the assessed variables. The highest mean age of the pigs during the pig performance tests was 173.7 ±10.10 days, in the sire line A. On the other hand, in the sire line E, the lowest mean age was 154.63 ±16.33 days and the differences between the lines were statistically significant (*P* <0.001). The mean weight of pigs in each sire line ranged from 104.97 to 113.9 kg, but the weight differences between lines were not statistically significant (*P* >0.05). The pig performance test is performed at a prescribed weight of 80–120 kg therefore, we did not expect any significantly differences in weight between the lines. Similarly, Augspurger et al. (2002) and Aymerich et al. (2019) found not significant differences between the evaluated lines of slaughter pigs. However, as shown by the findings of other authors sire line can have a significant effect on pig weight at slaughter (Elbert et al., 2020).

Significantly, the highest average daily gain (ADG_{100}) was achieved by lines E and D (669.6 ±10.34 g.day^{-1} and 666.9 ±3.26 g.day^{-1}, respectively) (*P* <0.05). In contrast, lines C and A achieved the lowest growth intensity (612.77 ±4.24 g.day^{-1} and 612.77 ±4.24 g.day^{-1}, respectively) (*P* <0.05), (Table 3). Similarly, the available literature shows that sire line or breed significantly influences the growth intensity of pigs (Szyndler-Nędza et al., 2016; Almeida et al., 2019; Aymerich et al., 2019).

In the back fat thickness trait (BFT_{100}), line C had the highest values (0.941 ±0.02 cm) and line D the lowest (0.871 ±0.01 cm), but the differences were not significant (*P* >0.05), (Table 3). Consistent with our findings, Elbert et al. (2020) found no significant effect of sire line on back fat thickness. However, most authors report a significant effect of sire line on back fat thickness in pigs (Latorre et al., 2003b; Schinckel et al., 2009; Aymerich et al., 2019).

Like backfat thickness height, there was no statistical difference (*P* >0.05) between the sire lines when assessing lean meat content (LMC_{100}) (Table 3). Differences between sire lines were minimal and ranged from 62.06 to 62.31%. In contrast to our findings, several authors found a significantly effect on lean meat content when comparing sire lines (Aymerich et al., 2019; Elbert et al., 2020; Manu et al., 2021).

Table 3 Effect of sire line on pig performance

S. L.	Age (day) ($\bar{x}$ ±SD)	Weight (kg) ($\bar{x}$ ±SD)	ADG_{100} (g.day^{-1}) ($\bar{x}$ ±SD)	BFT_{100} (cm) ($\bar{x}$ ±SD)	LMC_{100} (%) (±SD)
A (*n* = 10)	173.7 ±10.10^{b}	111.40 ±6.69^{ab}	612.9 ±11.13^{a}	0.935 ±0.04	62.19 ±0.15
B (*n* = 98)	170.16 ±14.58^{b}	110.49 ±8.22^{ab}	625.70 ±5.13^{ab}	0.902 ±0.02	62.30 ±0.09
C (*n* = 83)	171.66 ±13.70^{b}	108.84 ±9.15^{ab}	612.77 ±4.24^{a}	0.941 ±0.02	62.06 ±0.08
D (*n* = 11)	162.0 ±5.42^{ab}	113.9 ±6.32^{b}	666.9 ±3.26^{b}	0.871 ±0.01	62.31 ±0.06
E (*n* = 30)	154.63 ±16.33^{a}	104.97 ±10.41^{a}	669.6 ±10.34^{b}	0.904 ±0.02	62.10 ±0.15
P-value	*P* <0.001	NS	*P* <0.001	NS	NS

S.L. – sire line; ADG_{100} – average daily gain on 100 kg live weight; BFT_{100} – back fat thickness on 100 kg live weight; LMC_{100} – lean meat content on 100 kg live weight; $\bar{x}$ – mean; SD – standard deviation; a, b – different letters in the same column indicate significant differences among the mean values (*P* <0.05); NS – not significant

4 Conclusions

The results of the study confirm that gender, growth intensity and sire line had significantly affected the pig performance of breed Large White. Boars achieved a significantly higher average daily gain and lean meat content compared to gilts, while gilts had significantly higher back fat thickness. Growth intensity had a significant effect on all parameters studied. Pigs with higher growth intensity had a higher lean meat content and at the same time a lower back fat thickness. There were no significant differences in back fat thickness and lean meat content between sire lines, but differences in average daily gain were statistically significant. These findings indicate the possibility of selecting individuals with high growth performance without negatively impacting on carcass trait quality and support the application of growth performance as a selection criterion in pig breeding.

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Interests Declaration

The authors declare that there is no conflict of interest.

Author Contributions

Ivan Imrich: Conceptualization, Funding acquisition, Methodology, Project administration, Writing original draft; Daniel Rajčok: Data curation, Investigation, Methodology, Writing original draft; Eva Mlyneková: Data curation, Supervision, Validation, Writing review & editing; Tomáš Kanka: Validation, Technical support, Data analysis, Writing review & editing.

AI and AI-Assisted Technologies Use Declaration

No generative AI tools/AI-assisted technologies were used during the preparation of the manuscript.

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