QUANTITATIVE-GENETIC ANALYSIS OF INTENSITY GROWTH OF GILTS FERTILE BREED AND THEIR HYBRIDS IN THE NUCLEUS FARM

D. Lukač¹, V. Vidović¹, J. Krnjaić², V. Višnjić³, R. Šević⁴

¹University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21 000 Novi Sad, Republic of Serbia
²Delta Agrar, Napredak a.d., Golubinački put bb, 22300 Stara Pazova, Republic of Serbia
³Carnex Ltd. Meat industry, Kulski put 26, 21400 Vrbas, Republic of Serbia
⁴Meat Industry, Joint-Stock Company, Grupa Univerexport Bačka, Bačka Palanka, Republic of Serbia

Corresponding author: dragomirlukac@stocarstvo.edu.rs

Original scientific paper

Abstract: The paper analyzes the 2760 gilts four different genotypes, two of which are pure bred Landrace (429 gilts) and Yorkshire (421 gilts) and two hybrid F₁(YxL) (999 gilts) and F₁(LxY) (911 gilts), tested in the period from 2010 to 2011. Analyzed by the following traits of intensity growth: weight at weaning (WW), daily gain at suckling (DGS), weight in rearing (WR), daily gain at rearing (DGR), weight in test (WT), daily gain on test (DGT), weight of gilts (WG) and life gain (LG). Due to the manifestation of heterosis effect, hybrid gilts in rearing made any higher body weight of about 3 kg, while the age of 160 days on average had a higher body weight by 7.0 kg compared to the pure breed gilts, which resulted in higher daily gain in different phases of rearing. Degree of heritability for analysis traits of intensity growth is of medium to high. Heritability (h²) for daily gains were larger (0.640 for DGS, 0.858 for DGR and 0.859 for DGT) in relation to the heritability for achieved body weight (0.584 for WW, 0.558 for WR and 0.816 for WT) in different phases of rearing. Between the most observed traits were found positive genetic and phenotypic correlations. The negative correlation found between WR, DGR and WT, DGT (rₜ = -0.055 to -0.108; rₚ = -0.010 to -0.033), between WW, DGS and DGR (rₜ = -0.301 respectively -0.466; rₚ = -0.234 respectively -0.271).

Key words: intensity growth, gilts, heritability, genetic and phenotypic correlation
Introduction

Modern breeding animals involve genetic improvement of animals by applying the basic principles of quantitative genetics. In order to achieve this genetic improvement, it is necessary to properly select the superior parents of future generations. For all this it is necessary a good knowledge of genetic parameters heritability, correlation, covariance and variance (Thompson et al., 2005). Knowledge of the genetic parameters for economically important traits of animals is necessary, is essential in order to evaluate the breeding values of individuals, made an effective plan and program breeding, and evaluate effects of selection.

Today we have specialized pig farms, commercial and the nucleus farms. The nucleus of the farms are grandfather, grandparents and parents, were strict biosecurity regulations. There are only healthy animals with a minimum number of vaccinations. Repair of sows on these farms is about 150% and 300% boar. Commercial farms with slightly weaker biosafety regulations, higher number of vaccinations used for the production of hybrid pigs with a minimum expenditure of labor and cost price (Vidović et al., 2011). At European proportions, and in our crystallized are fertile breeds, Landrace and Yorkshire (Bidanel 2010; Bergsma et al., 2010). They are used for the production of F1 mothers that crossing with the terminal boar breed Duroc, Hampshire and Pietrain as well as their F1 product (synthetic boars that containing recombination of favorable genes for the most important traits) whose descendants are the final product.

The most significant intensification factors influencing production potential are growth intensity, food utilization and slaughter value. These traits pose major influence on the effectiveness of breeding and selection herds (Brzobohaty et al., 2012). Serrano et al. (2009) states that like any other characteristic, the growth intensity is the result of both internal (breed, sex, age) and environmental factors working together (nutrition, feeding technique, technology). Out of the external conditions, the nutrition of pigs was found to be of the greatest importance (Bee et al., 2007). Considering that quantitative traits and their expression are under the influence of several genes, they are under strong influence of environment factors. This shows the significance of accurate and precise assessment of these traits, as well as of the breeding value of the animal.

On the basis of the above, the objectives of this research was determine the intensity growth Landrace and Yorkshire gilts and and their hybrids, and evaluation of genetic parameters heritability, correlations and (co) variances examined traits.
Materials and Methods

Animals and studied traits

The paper, for quantitative-genetic analysis of intensity growth gilts were used results of a Nucleus farm capacity 400 sows pure breed Landrace and Yorkshire, which produces and hybrid gilts F₁ generation for other farms. Analyzed in total 2760 gilts four different genotypes, two of which are pure bred Landrace (429 gilts) and Yorkshire (421 gilts) and two hybrid F₁(YxL) (999 gilts) and F₁(LxY) (911 gilts), from 2010 to 2011. Analyzed by the following traits of intensity growth: weight at weaning (WW), daily gain at suckling (DGS), weight in rearing (WR), daily gain at rearing (DGR), weight in test (WT), daily gain on test (DGT), weight of gilts (WG) and life gain (LG).

Statistical analysis

The significance of the fixed effects and inclusion in the models were determined for each trait using the general linear model (GLM) procedures in software package Statistica 12. In order to examine the influence of the season, the year is divided into three seasons: Season I (November, December, January, February); Season II (March, April, September, October); Season III (May, June, July, August). How would we examined the effects of weight at birth, piglets were divided into six groups: group I (from 1000 to 1200 g), group II (from 1200 to 1400 g), group III (from 1400 to 1600 g), group IV (from 1600 to 18000 g), group V (from 1800 to 2000 g), group VI (> 2000 g).

To estimate genetic parameters, constructed the following model:

\[ Y_{ijklmn} = \mu + A_i + Y_j + S_k + B_l + BW_m + e_{ijklmn} \]

where \( Y_{ijklmn} \) = phenotypic values of traits; \( \mu \) = average mean; \( A_i \) = random influence of animal; \( Y_j \) = fixed influence of year; \( S_k \) = fixed influence of season; \( B_l \) = fixed influence of breed; \( BW_m \) = fixed influence of weight at birth; \( e_{ijklmn} \) = random error

Genetics parameters (heritability, correlations) including variance components, were estimated using the restricted maximum likelihood (REML) procedure based on an animal model using the Wombat program (Meyer, 2007) with multivariate analyses. The model can be represented in matrix terms by:

\[ y = Xb + Za + e \]
where \( y \) is the vector of observations; \( X \) is the incidence matrix of fixed effects; \( b \) is the vector of fixed effects; \( Z \) is the incidence matrix of random effects; \( a \) is the vector of random effects; \( e \) is the vector of residuals.

**Result and Discussion**

Table 1 shows the adjusted mean (LSM) and standard error of the adjusted mean (SE<sub>LSM</sub>) intensity growth gilts four genotypes. From the table we can see that the average weight at birth (WB) and weaning (WW) was slightly larger (100g respectively 800g) in hybrid gilts in relation to gilts pure breed. In the lactation period, which lasted for all 28 days, hybrid gilts have achieved higher average daily gain (DGS). A substantial advantage of the increase in the intensity growth of hybrid gilts can be seen in rearing, which lasted 52 days. In that period, hybrid gilts are achieved higher body weight (WR) for about 3 kg and daily gain (DGR) for about 100 g compared to gilts pure breed, so that F<sub>1</sub> gilts in the performance test entered with body weight of about 32 kg and gilts pure breed with about 28 kg. In the performance test, which lasted 80 days, the highest body weight (WT) of 73 kg had F<sub>1(YxL)</sub> gilts, then F<sub>1(LxY)</sub> gilts about 71.5 kg, and the lowest body weight (WT) of 66.8 kg had Yorkshire gilts, while Landrace gilts in performance test which lasted 82 days archived body weight (WT) of 71.2 kg. Daily gain in the test (DGT) ranged from 0.832 in Yorkshire to 0.905 in F<sub>1(YxL)</sub> gilts. Finally, with a total age of 160 days, F<sub>1(YxL)</sub> gilts achieved the body weight (WG) of 104.6 kg, F<sub>1(LxY)</sub> gilts 102.4 kg, 99.1 kg Landrace gilts and 93.7 kg Yorkshire gilts.

Many authors have found significant differences in the intensity growth between gilts of different genotypes on commercial farms. Thus, the research Brkić et al. (2001), gilts F<sub>1(LxY)</sub> achieved better results for the traits of intensity growth compared to Landrace gilts. With the age of 209 days, archived an WG 103.81 kg and LG 491 g. The study Gjerlaug-Enger et al. (2011) DGS in Landrace was 390g, and DGT 100 kg 905 g. Vuković et al. (2007) are in hybrid gilts with the age of 190 days recorded WG of 99.83 kg, and LG 526 g. Szyndler-Nedzi et al. (2010) are in gilts with ages from 150 to 210 days, recorded WG of 104.7 kg and LG of 630 g in Yorkshire, 105.5 kg WG and LG of 633 g in Landrace, 111.9 kg WG and LG 658 g in Duroc, 116.9 kg WG and LG of 655 g in Pietrain gilts. Kawecka et al. (2009) are in gilts aged 180 days, recorded WG 120 kg and 701 g DGT. Szostak (2011) notes that now gilts intended for reproduction much sooner gain the weight of 110–120 kg, which has often been, and still is, the criterion for taking the decision concerning the time of the first mating. This too rapid growth rate and a small amount of fat may have a negative effect on the reproductive functions of primiparous gilts (Matysiak et al. 2010; Amaral Filha et al., 2010).
Table 1. Intensity growth of gilts

| Traits                          | Landrace | Yorkshire | F1(LxY) | F1(YxL) |
|--------------------------------|----------|-----------|---------|---------|
|                                | LSM      | SELsLm   | LSM     | SELsLm  | LSM     | SELsLm   | LSM     | SELsLm |
| Lactation length, days.         | 28.00    | 28.00     | 28.00   | 28.00   | 28.00   | 28.00    |
| Weight at birth, kg (WB)        | 1.344    | 0.010     | 1.380   | 0.010   | 1.443   | 0.006    | 1.415   | 0.007  |
| Weight at weaning, kg (WW)      | 7.030    | 0.088     | 6.722   | 0.089   | 7.810   | 0.058    | 7.665   | 0.060  |
| Daily gain at suckling, kg (DGS)| 0.201    | 0.002     | 0.191   | 0.002   | 0.220   | 0.001    | 0.220   | 0.001  |
| Rearing length, days            | 51.00    | 52.00     | 52.00   | 52.00   |
| Weight in rearing, kg (WR)      | 20.829   | 0.276     | 20.228  | 0.278   | 23.798  | 0.180    | 23.330  | 0.189  |
| Daily gain at rearing, kg (DGR) | 0.262    | 0.005     | 0.252   | 0.005   | 0.313   | 0.003    | 0.302   | 0.003  |
| Duration of test, days          | 82.00    | 80.00     | 80.00   | 80.00   |
| Weight in test, kg (WT)         | 71.191   | 0.648     | 66.802  | 0.654   | 72.993  | 0.424    | 71.433  | 0.444  |
| Daily gain on test, kg (DGT)    | 0.865    | 0.006     | 0.832   | 0.06    | 0.905   | 0.004    | 0.886   | 0.004  |
| Age of gilts, days              | 161.00   | 160.00    | 160.00  | 160.00  |
| Weight of gilts, kg (WG)        | 99.109   | 0.711     | 93.693  | 0.718   | 104.608 | 0.466    | 102.411 | 0.488  |
| Life gain, kg (LG)              | 0.601    | 0.003     | 0.573   | 0.003   | 0.644   | 0.002    | 0.630   | 0.002  |

Residual, direct additive genetic variance components and phenotypic, residual and direct heritability with standard errors for the intensity growth of gilts are shown in Table 2. From Table 2 it can be seen that all traits intensity growth of medium to high degree of heritability. Heritability (h²) for daily gains were larger (0.640 for DGS, 0.858 for DGR and 0.859 for DGT) in relation to the heritability for achieved body weight (0.584 for WW, 0.558 for WR and 0.816 for WT) in different phases of rearing. Less additive genetic variance (V_a) were recorded in daily gain compared to additive genetic variance archived body weight. Larger heritability estimates but lower than our for growth traits were given by other authors. Gjerlaug-Enger et al. (2011) found heritability for DGR 0.25 in Landrace and 0.48 in Duroc, for DGT 0.41 in Yorkshire and 0.42 in Duroc. Heritability for DGT in the range of 0.27 to 0.58 in its research were given Szynler-Nedzi et al. (2010) in Yorkshire (0.29), Landrace (0.39) and Duroc (0.58) gilts, Hoque and Suzuky (2008) of Duroc (0.38) and Landrace (0.47) gilts, Imboonta (2007) in Landrace (0.38) gilts, Gilbert et al. (2007) in Yorkshire gilts (0.35). Slightly lower heritability for DGT (0.19) and LG (0.16) found Nguyen and McPhee (2005) for Yorkshire gilts, Szynler-Nedzi et al. (2010) for the DGT (0.16.) in Pietrain gilts. Chimonyo and Dzama (2007) for DGR obtain heritability from
0.15 to 0.27 in Landrace, and Hermesch et al. (2000) for the DGR 0.10 and for DGT 0.48 in Landrace.

Table 2. Variance and heritability for intensity growth of gilts

| Traits | $V_e$ | $V_a$ | $V_p$ | $h^2$ | SE $h^2$ | $h^2$ | SE $h^2$ |
|--------|-------|-------|-------|-------|----------|-------|----------|
| WB     | 0.180 | 4.070 | 4.250 | 0.042 | 0.055    | 0.055 |          |
| WW     | 0.196 | 0.275 | 0.471 | 0.416 | 0.056    | 0.584 | 0.056    |
| DGS    | 13.456| 23.897| 37.354| 0.360 | 0.056    | 0.640 | 0.056    |
| WR     | 0.574 | 0.724 | 1.299 | 0.442 | 0.056    | 0.558 | 0.056    |
| DGR    | 19.102| 115.569| 134.671| 0.142 | 0.052    | 0.858 | 0.052    |
| WT     | 0.358 | 1.594 | 1.952 | 0.184 | 0.057    | 0.816 | 0.057    |
| DGT    | 27.025| 164.576| 191.601| 0.141 | 0.055    | 0.859 | 0.055    |
| WG     | 0.205 | 0.500 | 0.705 | 0.291 | 0.057    | 0.709 | 0.057    |

$V_e$ – residual variance; $V_a$ – additive genetic variance; $V_p$ – phenotypic variance; $h^2$ – heritability; SE $h^2$ – standard error of heritability

Genetic and phenotypic covariances and correlations between traits are presented in Table 3 and 4. Negative genetic and phenotypic covariances were obtained between DGS and WR, DGR, between WR and WT, DGT, between DGR and WT, DGT, between WW and DGR. Between the most observed traits were positive genetic and phenotypic correlations. Very strong positive genetic and phenotypic correlations were found between WT, DGT and WG, LG ($r_g = 0.709$ to 0.953; $r_p = 0.810$ to 0.942), while weak negative correlation was found between WR, DGR and WT, DGT ($r_g = -0.055$ to -0.108; $r_p = -0.010$ to -0.033) and medium negative correlation between WW, DGS and DGR ($r_g = -0.301$ respectively -0.466; $r_p = -0.234$ respectively -0.271). Positive genetic correlation between the DGR and DGT are obtained in Landrace ($r_g = 0.15$) and Duroc ($r_g = 0.40$).

Table 3. Genetic (above the diagonal) and phenotypic (below the diagonal) covariance between traits

| Traits | WW | DGS | WR | DGR | WT | DGT | WG | LG |
|--------|----|-----|----|-----|----|-----|----|----|
| WW     | 1.000 | 0.736 | 0.547 | -0.456 | 3.931 | 0.519 | 8.644 | 0.371 |
| DGS    | 1.086 | 0.736 | -0.185 | -0.208 | 1.072 | 0.136 | 1.666 | 0.115 |
| WR     | 0.335 | -0.254 | 1.000 | 0.882 | -6.072 | -0.055 | 22.219 | 0.133 |
| DGR    | -0.523 | -0.211 | 6.161 | 1.000 | -0.797 | -0.115 | 1.733 | 0.681 |
| WT     | 4.258 | 1.096 | -0.795 | -0.422 | 1.000 | 11.506 | 141.924 | 6.099 |
| DGT    | 0.508 | 0.127 | 0.147 | -0.521 | 14.703 | 1.000 | 14.063 | 0.832 |
| WG     | 8.708 | 1.998 | 38.055 | 4.772 | 149.600 | 16.301 | 1.000 | 8.242 |
| LG     | 0.469 | 0.138 | 1.605 | 0.241 | 7.688 | 0.705 | 10.280 | 1.000 |

$V_e$ – residual variance; $V_a$ – additive genetic variance; $V_p$ – phenotypic variance; $h^2$ – heritability; SE $h^2$ – standard error of heritability
Table 4. Genetic (above the diagonal) and phenotypic (below the diagonal) correlation between traits

| Traits | WW  | DGS | WR  | DGR | WT  | DGT | WG  | LG  |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|
| WW     | 1.000 | 0.796 | 0.052 | -0.301 | 0.162 | 0.231 | 0.326 | 0.295 |
| DGS    | 0.810 | 1.000 | -0.185 | -0.466 | 0.192 | 0.206 | 0.248 | 0.304 |
| WR     | 0.026 | -0.061 | 1.000 | 0.882 | -0.096 | -0.055 | 0.322 | 0.133 |
| DGR    | -0.234 | -0.271 | 0.885 | 1.000 | -0.088 | -0.108 | 0.157 | 0.113 |
| WT     | 0.170 | 0.138 | -0.010 | -0.032 | 1.000 | 0.953 | 0.899 | 0.883 |
| DGT    | 0.186 | 0.133 | 0.017 | -0.033 | 0.942 | 1.000 | 0.901 | 0.709 |
| WG     | 0.302 | 0.210 | 0.435 | 0.302 | 0.879 | 0.853 | 1.000 | 0.933 |
| LG     | 0.285 | 0.027 | 0.312 | 0.252 | 0.810 | 0.821 | 0.891 | 1.000 |

Ve – residual variance; Va – additive genetic variance; Vp – phenotypic variance; h² – heritability of residual variance; h² – heritability; SEh² – standard error of heritability

According to Rosycki et al. (2003) and Nowachowicz et al. (2012) any genetic progress in growth traits that occurs in a population is the result of breeding those animals that have achieved significant results in a performance test and had a good breeding values. Good selection of gilts with knowledge of quantitative genetic parameters, can be achieved faster genetic progress and faster to improve the desired traits.

Conclusions

Based on these results we can conclude that the hybrid gilts had higher intensity growth in rearing and later in the performance test in relation to gilts pure breed, which resulted in higher body weight at the end of the test, which can be explained by the manifestation of heterosis effect in hybrid gilts. Degree of heritability for traits analysis of intensity of growth is medium to high and is slightly larger than the results of other authors, which can be explained by the fact that gilts from nucleus farms, which originate from genetically quality parents and where apply a high selection criteria. The most traits intensity growth of medium to high degree of heritability. Between the most observed traits were positive genetic and phenotypic correlations. Obtained results of intensity growth should be monitored and analyzed at all times, because the analysis of the results of intensity growth gilts, in terms of heritability and correlations that arise between traits, it is possible to estimate the changes that occur in the population, which can be used in pig breeding programs.
Acknowledgment

Research was financially supported by the Ministry of Science and Technological Development, Republic of Serbia, with in the project TR 31032.

Kvantitativno-genetska analiza intenziteta porasta nazimica plodnih rasa i njihovih hibrida u Nukleus zapatu

D. Lukač, V. Vidović, J. Krnjaić, V. Višnjić, R. Šević

Rezime

U radu je analizirano 2760 nazimica četiri različita genotipa, od kojih su dva čiste rase landras (429 nazimica) i jorkšir (421 nazimica) i dve hibridne $F_{1(YXL)}$ (999 nazimica) i $F_{1(LXY)}$ (911 nazimica), u periodu od 2010 do 2011 godine. Analizirane su sledeće osobine intenziteta porasta: masa na zalučenju (WW), dnevni prirast na sisi (DGS), masa u odgoju (WR), dnevni prirast u odgoju (DGR), masa u testu (WT), dnevni prirast u testu (DGT), ukupna masa nazimica (WG) i životni prirast (LG). Usled manifestacije heterozis efekta, hibridne nazimice su u odgoju ostavile veću telesnu masu za oko 3 kg, dok su su sa istom starosti od 160 dana prosečno imale veću telesnu masu za 7.0 kg u odnosu na nazimice čiste rase, što je rezultiralo i većim dnevnim prirastima u pojedinim fazama odgoja. Analizirane osobine intenziteta porasta su imale srednji do visok stepen heritabiliteta. Heritabilnosti ($h^2$) za dnevne priraste su bile nešto veće (0.640 za DGS, 0.858 za DGR i 0.859 za DGT) u odnosu na heritabilnosti za ostavrene telesne mase (0.584 za WW, 0.558 za WR, i 0.816 za WT) u pojedinim fazama odgoja. Između većine posmatranih osobina zabeležene su pozitivne genetske i fenotipske korelacije. Negativne korelacije ustanovljene između WR, DGR i WT, DGT ($r_g = -0.055$ to $-0.108$; $r_p = -0.010$ to $-0.033$) i između WW, DGS i DGR ($r_g = -0.301$ odnosno $-0.466$; $r_p = -0.234$ odnosno $-0.271$).

References

AMARAL FILHA W.S., BERNARDI M.L., WENTZ I., BORTOLOZZO F.P. (2010): Reproductive performance of gilts according to growth rate and backfat thickness at mating. Animal Reproduction Science, 121, 139–144.
BEE G., CALDERINI M., BOLLEY C., GUEX G., HERZOG W., LINDEMANN M. D. (2007): Changes in the histochemical properties and meat quality traits of porcine muscles during the growing-finishing period as affected by feed restriction, slaughter age, or slaughter weight. Journal of Animal Science, 5, 1030-1045.
BERGSMA R., KANIS E., VERSTEGEN M., KNOL, E. (2010): Genetic correlations between lactation performance and growing-finishing traits in pigs. WCGALP, 697, Leipzig, Germany.

BIDANEL J. P. (2010): Genetic Associations of growth and Feed Intake with other Economically Important Traits in pigs. WCGALP, 895, Leipzig, Germany.

BRKIĆ N., GAJIĆ Ž., PUŠIĆ M. (2001): The genetic and phenotypic variability and relationship of some growth and slaughter characteristics of the performance tested gilts. Genetika, 33, 1-10.

BRZOBOHATÝ L., STUPKA R., ČITEK J., ŠPRYSL M., OKROUHLÁ M., VEHOVSKÝ K. (2012): The influence of growth intensity during different age periods on muscle fiber characteristics in pigs. Research in Pig Breeding, 6, 2.

CHIMONYO M., DZAMA K. (2010): Estimation of genetic parameters for growth performance and carcass traits in Mukota pigs. Animal, 1, 317–323.

GILBERT H., BIDANEL J.P., GRUAND J., CARITEZ J.C., BILLON Y., GUILLOUET P., LAGANT H., NOBLET J., SELLIER P. (2007): Genetic parameters for residual feed intake in growing pigs, with emphasis on genetic relationships with carcass and meat quality traits. Journal of Animal Science, 85, 3182–3188.

GJERLAUG-ENGER E., KONGSRO J., ODEGARD J., AASS L., VANGEN O. (2011): Genetic parameters between slaughter pig efficiency and growth rate of different body tissues estimated by computed tomography in live boars of Landrace and Duroc. Animal, 6, 9–18.

HERMESCH S., LUXFORD B.G., GRASER H.U. (2000): Genetic parameters for lean meat yield, meat quality, reproduction and feed efficiency traits for Australian pigs 2. Genetic relationships between production, carcase and meat quality traits. Livestock Production Science, 65, 249–259.

HOQUE A., SUZUKI K. (2008): Genetic parameters for production traits and measures of residual feed intake in Duroc and Landrace pigs. Animal Science Journal, 79, 543–549.

IMBOONTA N., YDHMER R.L., TUMWASORN S. (2007). Genetic parameters for reproduction and production traits of Landrace sows in Thailand. Journal of Animal Science, 85, 53–59.

KAWECKA M., MATYSIAK B., KAMYCZEK M., DELIKATOR B. (2009): Relationships between growth, fatness and meatiness Traits in gilts and their subsequent reproductive performance. Annals of Animal Science, 9, 249-258.

MATYSIAK B., KAWĘCKA M., JACYNO E., KOŁODZIEJ-SKALSKA A., PIETRUSZKA A. (2010): Relationships between test of gilts before day at first mating on their reproduction performance. Acta Scientiarum Polonorum Zootechnica, 9, 29–38

MEYER K. (2007): WOMBAT software (Animal Genetics and Breeding Unit. University of New England, Armidale NSW 2351, Australia.)
NGUYEN N.H., MCPHEE C.P. (2005): Genetic Parameters and Responses in Growth and Body Composition Traits of Pigs Measured under Group Housing and Ad libitum Feeding from Lines Selected for Growth Rate on a Fixed Ration. Asian-Australian Journal of Animal Science, 18, 1075-1079.

NOWACHOWICZ J., MICHALSKA G., WASILEWSKI P.D., BUCEK T. (2012): The analysis of the performance test results including correlation between the traits of this evaluation in crossbred gilts. Journal of Central European Agriculture, 13, 681-694.

ROSYCKI M. (2003): Selected traits of Polish pedigree pig-progress in the carcass meat deposition and meat quality. Animal Science Papers and Reports, 21, 163-171.

SERRANO M. P., VALENCIA D. G., FUENTETAJA A., LÁZARO R., MATEOS G. G. (2009): Influence of feed restriction and sex on growth performance and carcass and meat quality of Iberian pigs reared indoors. Journal of Animal Science, 87, 1676-1685.

STATSOFT, INC. (2013). Statistica (data analysis software system), version 12. www.statsoft.com

SZOSTAK B. (2011): The influence of the intensity of the growth of gilts on the reproduction performance in first farrow. Acta Scientiarum Polonorum Zootechnica, 10, 141–148.

SZYNDLER-NEDZA M., TYRA M., RÓZYCKI M. (2010): Coefficients of heritability for fattening and slaughter traits included in a modified performance testing method. Annals of Animal Science, 10, 117–125.

THOMPSON R., BROTHERSTONE S., WHITE I. M. S. (2005): Estimation of quantitative genetic parameters. Philosophical Transactions of the Royal Society B, 360, 1469–1477.

VIDOVIĆ V., VIŠNJIĆ V., JUGOVIĆ D., PUNOŠ D., VUKOVIĆ N. (2011): Praktično svinjarstvo. APROSIM. Novi Sad, 287 pp.

VUKOVIĆ V., ANDONOV S., KOVAČ M., KOČEVSKI D., MALOVRH S. (2007): Estimation of genetic parameters for number of teats and traits from performance test of gilts. 3rd Joint Meeting of the Network of Universities and Research Institutions of Animal Science of the South Eastern European Countries, Thessaloniki February 10-12.

Received 11 May 2015; accepted for publication 25 June 2015