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

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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 $F_{1(YxL)}$ (999 gilts) and $F_{1(LxY)}$ (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 (h^2) 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 (r_g= -0.055 to -0.108; r_p = -0.010 to -0.033), between WW, DGS and DGR (r_g= -0.301 respectively -0.466; r_p = -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 F_1 mothers that crossing with the terminal boar breed Duroc, Hampshire and Pietrain as well as their F_1 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 F_1 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 $F_{1(YxL)}$ (999 gilts) and $F_{1(LxY)}$ (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; μ = 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_{Lsm}) 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_1 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 $F_{1(YxL)}$ gilts, then $F_{1(LxY)}$ 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 $F_{1(YxL)}$) gilts. Finally, with a total age of 160 days, $F_{1(YxL)}$ gilts achieved the body weight (WG) of 104.6 kg, $F_{1(LxY)}$ 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 $F_{1(LxY)}$ 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		$F_{1(YxL)}$		$F_{1(LxY)}$	
	LSM	SE_{Lsm}	LSM	SE_{Lsm}	LSM	SE_{Lsm}	LSM	SE_{Lsm}
Lactation length, days,	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 bee seen that all traits intensity growth of medium to high degree of heritability. Heritability (h^2) 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 *Szynder-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, *Szynder-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_e^2	SEh_e^2	h^2	SEh^2
WB	0.180	4.070	4.250	0.042	0.055	0.958	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_e^2 – heritability of residual variance; h^2 – heritability; SEh^2 – standard error of heritability

Genetic and phenotypic covariances and correlations between traits are presented in Table 3 and 4. Negative genetic and phenotypic covarijanse 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 obtain *Hermesch et al (2000)* (r_g = 0.32), *Gjerlaug-Enger et al. (2011)* 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	**1.000**	-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	38.085	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_e^2 – heritability of residual variance; h^2 – heritability; SEh^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**

V_e – residual variance; V_a – additive genetic variance; V_p – phenotypic variance; h_e^2 – heritability of residual variance; h^2 – heritability; SEh^2 – 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 breading 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.

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

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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 ostavrile 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 viskog 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).

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