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INFLUENCE OF SOME GENETIC AND ENVIRONMENTAL FACTORS ON THE PRODUCTIVITY OF DANUBE WHITE PIGS

II. EFFECT OF THE LINE, YEAR AND SEASON ON THE PRODUCTIVITY OF PIGS WITH SIMILAR GENOTYPES

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ABSTRACT

The effect of lines, years, seasons and the interaction among blood grading, year and season on the productive traits of 960 Danube White pigs were studied for three generations. The estimations of the factors studied were carried out by multifactor analyses. The interaction among blood grading, year and season was studied by a two-trait model. Significant influence of the line ($P \leq 0.05$) and year ($P \leq 0.001$) was established with respect to the traits studied (growth rate and lean meat percentage up to 90 kg live weight). The season influenced significantly the growth rate ($P \leq 0.001$) only. The effect of the interaction among blood grading, year and season established favourable influence on the crosses compared to the other part of the population.

Key words: Danube White breed; interaction; environmental factors

INTRODUCTION

The optimal use of the genetic resources and the effect of crossing between the breeds determine the productivity of the animals bred. Individuals' genotypes differ on the adaptation level to the specific environment. Animals from lines with high adaptability to the environment which are raised under optimal conditions show high productivity and *vice versa*. With this respect animals with lower adaptability are characterized by the same productivity under different environmental conditions and in spite of their lower productivity they are more suitable for breeding under unfavourable conditions (Via et al., 1995, Merks et al., 2005).

Environmental factors influence the growth rate and utilization of feed (Schinckel et al., 2001; Wolter et al., 2002). The same authors reported that the conventional breeding which was typical of a part of the commercial farms was characterized by worse conditions of feeding and breeding, lower hygiene and smaller area per pig in the pen. Falconer (1990) noticed that by stabilizing the selection to the environmental conditions, the environmental variance was expected to decrease. According to Scheiner (2002) and Zumbach et al. (2007), breeding of animals should be organized towards directing the selection to maintaining constant phenotype in constantly varying environment.

The objective of this study was to establish the effect of line, year and season on the productivity of pigs with similar genotypes.

MATERIAL AND METHODS

A study on the productivity of 960 Danube White pigs was carried out during the period 2004 – 2008. The results of the basic selection traits were analyzed: growth rate and lean meat percentage up to 90 kg live weight were measured by means of Piglog 105. The animals were fed and raised under traditional conditions.

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The estimations of the factors studied (rate of replacement and culling, line, year and season) were established by multifactor analyses (Harvey, 1990). The effect of the interaction among blood grading, year and season (blood grading$_*$year$_*$season) was established by a model including covariance of both traits (two-trait model; Groenveld, 1990). The traits – growth rate and lean meat percentage up to 90 kg were presented as a function of the interaction between the degrees of grading, year and season.

The following model was used:

Lm = blood grading$_*$year$_*$season

Age = blood grading$_*$year$_*$season

RESULTS

The replacement animals regularly exceeded the other part of the population. The differences were statistically significant (P ≤ 0.05 and P ≤ 0.001; Table 1). The analysis of variance of the traits showed that the lean meat percentage was significantly influenced by the rate of replacement and culling (P ≤ 0.01), the line (P ≤ 0.05) and the year (P ≤ 0.001), whereas the season did not influence this trait. The growth rate of the pigs tested was significantly influenced by the factors included into the analysis (P ≤ 0.001), whereas the influence of the line was slightly lower (P ≤ 0.05). The values characterizing

Table 1: Analysis of variance of traits studied

Trait	Number,n/degree of freedom, df	Lean meat percentage, LSM±LSE	Age, days LSM±LSE
Replacement animals	579	50.55±0.48a	249.5±6.6b
Culled animals	381	50.02±0.48a	270.9±6.7b
Rate of replacement and culling	1	++	+++
Line	7	+	+
Year	4	+++	+++
Season	3	ns	+++
C		4.90	12.43
R		0.822	0.620

Significance of differences: a - P ≤ 0.05 and b - P ≤ 0.001; R – Coefficient of determination; C – Variation coefficient

Table 2: Influence of line, year and season on the productivity traits

Factor		Number, n	Lean meat percentage, % LSC±LSE	Age, days LSC±LSE	Significance of differences: Age	Significance of differences: Lean meat percentage
LSM±LSE		960	50.28±0.47	260.25±6.53		
Line	I	184	-0.36±0.42	-4.71±5.86	5^{+} 1 8^{+++} 2 $^{+++}$ 3 $^{+++}$ 8 - 4 $^{+++}$ 5 $^{+++}$ 6 $^{+++}$ 7 $^{+++}$	2 $^{+}$ 6 7^{++} 3 $^{+}$ 4 $^{+}$ 7 8^{+}
	II	104	-0.61±0.47	1.72±6.51		
	III	152	-0.67±0.42	0.03±5.83		
	IV	165	-0.26±0.44	-3.29±6.02		
	V	120	-0.48±0.45	3.25±6.35		
	VI	115	0.25±0.46	0.94±6.36		
	VII	65	-1.11±0.48	-1.55±6.60		
	VIII	54	0.11±0.47	-21.04±6.45		
Year	2004	92	0.12±0.57	4.92±7.88	2004 2005^{+++} 2006^{+++} 2007^{+++} 2008^{++}	2004 2005^{+++} 2006^{++} 2007^{+++}
	2005	208	-1.48±0.51	-22.17±7.11	2005 2007^{+++} 2008^{+++}	2005 2006^{+} 2007^{+++} 2008^{+++}
	2006	225	-0.86±0.50	-17.22±6.92	2006 2007^{+++} 2008^{+++}	2006 2007^{+++} 2008^{+++}
	2007	235	1.38±0.50	17.24±6.89		2007 - 2008^{+}
	2008	200	0.84±0.47	17.24±6.45		
Season	Winter	218	0.13±0.50	3.26±6.90	1 - 3^{++} 1^{+++} 4 2 $^{+++}$ 3 $^{+++}$	
	Spring	274	0.04±0.50	7.02±6.95		
	Summer	280	-0.13±0.50	7.88±6.88		
	Autumn	188	-0.05±0.49	-18.15±6.70		

Significance of differences: $^{+}$ - P ≤ 0.05; $^{++}$ - P ≤ 0.01; $^{+++}$ - P ≤ 0.001

the variation coefficients were in narrow margins: 4.9% and 12.4%.

The influence of the line, year and season on the traits studied is given in Table 2. The lean meat percentage was higher in the pigs from line six (50.53%). Significant differences were found between that line and second and third lines: 0.86% and 0.92%, respectively ($P \leq 0.05$), and the seventh line: 1.36% ($P \leq 0.01$). The animals from lines four and eight also exceeded those from line seven ($P \leq 0.05$). With respect to the age of reaching 90 kg live weight, it was established that the animals from line eight grew most intensively (239.2 days) and the differences between the other lines were significant ($P \leq 0.001$). The pigs from line one significantly exceeded those from line five by 8 days ($P \leq 0.05$).

The influence of the year and season on the selection traits is also presented in the same table. The analysis of the results established that the lean meat percentage was the highest in the pigs tested in 2007 (51.66%) and they grew most intensively in 2005 and 2006. The differences between the years for both selection traits (except for 2005 and 2006) were significant. It was established with respect to the influence of season that the pigs grew more intensively during the autumn compared to the other seasons ($P \leq 0.01$). The differences between the winter and spring were also significant ($P \leq 0.01$).

The correlations between the basic selection traits were positive and showed higher influence of the individuals' genotype ($r_g = 0.467$) compared to the relatively low phenotypic and environmental correlations (Table 3). The results characterizing the additive variability established that the heritability of growth rate was lower by 6.3% compared to the lean meat percentage. Our results are in unison with those of other authors (Huisman et al., 2002; Newcom et al., 2005; van Wijk et al., 2005).

Table 3: Correlation coefficients and sources of additive genetic and environmental variability

Trait	r_g	r_p	r_e
Lean meat percentage/Age	0.467	0.188	0.104
Source of variability	h^2	σ_g	σ_e
Lean meat percentage, %	0.263±0.11	0.43	6.12
Age, days	0.203±0.09	62.2	1165

The results characterizing the variability of the traits studied are also given in the same table. High values of the environmental variance: 0.43 and 1165 (93-

Table 4: Estimation of the interaction among blood grading, year and season (grading$_*$ year$_*$ season) for growth rate and lean meat percentage of pigs with similar genotypes

Grading of boars	Season	2004 Lean meat, %	2004 Age, days	2005 Lean meat, %	2005 Age, days	2006 Lean meat, %	2006 Age, days	2007 Lean meat, %	2007 Age, days	2008 Lean meat, %	2008 Age, days
100% grading DW	Winter	-0.428	6.681	-2.501	-40.619	-0.639	-16.129	1.522	21.881	3.098	42.711
	Spring			-1.865	-20.439	-1.05	1.511	0.276	37.711	1.083	13.561
	Summer			-2.659	4.011	-1.524	-7.719	2.034	33.871	1.223	63.151
	Autumn	-1.621	-1.269	-2.505	-37.559	-0.987	-42.639	4.07	31.961	-0.802	-41.329
50% grading F_1	Winter							2.973	18.901	6.198	63.091
	Spring					-1.219	-41.929	3.628	40.401	4.898	9.831
	Summer					-1.9	-29.189	5.38	12.361		
	Autumn					1.748	-46.399	7.748	14.401	3.648	-45.469
25% grading F_2	Winter									0.67	26.511
	Spring									1.148	12.281
	Summer							0.027	-11.539	1.823	69.651
	Autumn							4.819	36.541	-0.131	-43.959
50% (25% + 25% GGP) F_2	Winter										
	Spring									-0.052	-33.599
	Summer										
	Autumn									-2.852	-61.599
12.5% grading F_3	Winter									-0.402	-13.599
	Spring										
	Summer										
	Autumn									-2.652	-57.169

Note: GGP – Great-grand parents. Grading from Large White x Landrace and new genotype from the Danube White breed

95% of the total variance), were noted in comparison to the genetic variance, which caused the lower additive variability.

The estimations of the interaction among blood grading, year and season (blood grading$_*$year$_*$season) followed the above mentioned trend (Table 4). It was noticed that 2007 and partially 2008 being unfavourable with respect to the management and feeding, negatively influenced the productivity of the population studied. The analysis of the results characterizing the interactions for the growth rate showed that purebred animals grew intensively during the period 2004 – 2006, whereas the values characterizing the trait deteriorated during the period 2007 – 2008. The pigs with 50% blood grading - F_1 grew more intensively in 2006 and in the autumn of 2008. The same trend was observed with respect to the crosses with 12.5% and 50% - GGP and for the rest crosses during the autumn. The interactions characterizing the lean meat percentage followed the trend mentioned above with respect to the age of reaching 90 kg live weight, which was due to the average to high genetic correlation between them (r_g = 0.467).

In conclusion, from the ranking of pigs with different percentages of blood gradings compared to the other part of the population it was established that crosses had favourable influence on the productivity of pigs, except for during 2007.

DISCUSSION

The study included animals up to third generation which were not subject of intrabreed breeding i.e., one of the parents was always purebred animal. This explained the better results of the traits obtained for the crosses compared to the purebred animals. On the other hand, the presence of recombination effects led to a decrease in the lean meat percentage and to an increase in growth rate. Cassady et al. (2002) in a similar study found that recombination effects decreased the loin eye area and increased the growth rate and feed utilization. Same authors emphasized that the crosses from purebred parents - first generation (F_1) expresses 100% of available heterosis and favourable epistatic effects are maintained. In the next generations, when a crossbred animal reproduces, epistatic effects are broken up due to recombination during gamete formation. If one or both parents are crossbred, progeny would again express 100% of available heterosis. However, epistatic effects which existed in purebred animals have now been partially broken up.

We established slightly higher environmental variance (1.5%) with respect to the age compared to the lean meat percentage, which was typical of the fattening qualities compared to the slaughter ones. The values of environmental variability shown in the study explained the comparatively low values of heritability. Zumbach et al. (2007) established that the animals from the same breed (two populations - Duroc) which were raised under the same conditions were characterized by different variance of the traits measured: one population showed from 18 - 97% higher environmental variance and 25 – 30% lower additive variance, which determined lower values of heritability coefficients.

The study noted that the year and season, the conditions of feeding and breeding, respectively, significantly influenced the productive qualities. That's why the selection of pigs from the population studied which was carried out under changing environmental conditions should be in conformity with individuals' adaptation and the possibilities of achieving rapid genetic gain. De Jong and Bijma (2002) and Schinckel et al. (2001) from two separate studies emphasized that the individuals' adaptability to the environment, also called phenotypic plasticity, was an inheritable trait subject to estimation.

CONCLUSIONS

From the above mentioned results it may be concluded that the line, year and season are factors which significantly influence the phenotypic variance of the selection traits studied. Also, the effect of the interaction among bllod grading, year and season (blood grading$_*$year$_*$season) was found to establish favourable influence of the crosses compared to the other part of the population.

REFERENCES

CASSADY, J. – YOUNG, L. – LEYMASTER, K. 2002. Heterosis and recombination effects on pig growth and carcass traits. *J. Anim. Sci.,* vol. 80, p. 2286-2302.

DE JONG, G. – BIJMA, P. 2002. Selection and phenotypic plasticity in evolutionary biology and animal breeding. *Livest. Prod. Sci.*, vol. 78, p. 195-214.

HARVEY, W. 1990. Users guide for LSMLMW & MIXMDL PC-2 version, Mimeo, Ohio, 90 p.

HUISMAN, A.E. – VEERKAMP, R. F. – VAN ARENDONK, G. A. 2002. Genetic parameters for various random regression models to describe the weight data of pigs. J. Anim. Sci., vol. 80, p. 575-582.

FALCONER, D. S. 1990. Selection in different environments: Effects on environmental sensivity (reaction norm) and on mean performance. *Genet. Res. Camb.*, vol. 56, p. 57-70.

MERKS, J. – KNOL, E. – HANENBERG, E. 2005. Developments in international pig breeding programmes. Proc. 56th Annu. Meet. EAAP, Uppsala, Sweden. Wageningen Academic Publishers, Wageningen, the Netherlands.

NEWCOM, D. W. – BAAS, T. J. – SCHWAB, C. R. – STALDER, K. J. 2005. Genetic and phenotypic relationships between individual subcutaneous backfat layers and percentage of longissimus intramuscular fat in Duroc swine. *J. Anim. Sci.*, vol. 83, p. 316-323.

SCHINCKEL, A. P. – WAGNER, J. R. – FORREST, J. C. – EINSTEIN, M. E. 2001. Evaluation of alternative measures of pork carcass composition. *J. Anim. Sci.,* vol. 79, p. 1093-1119.

SCHEINER, S. M. 2002. Selection experiments and the study of phenotypic plasticity. *J. Evol. Biol.*, vol. 15, p. 889-898.

VAN WIJK, H. J. – ARTS, D. J. – MATTHEWS, J. O. – WEBSTER, M. – DUCRO, B. J. – KNOL, E. F. 2005. Genetic parameters for carcass composition and pork quality estimated in a commercial production chain. *J. Anim. Sci.*, vol. 83, p. 324-333.

VIA, S. – GOMULKIEWICZ, R. – DE JONG, G. – SCHEINER, S. M. – SCHLICHTING, C. D. – VAN TIENDEREN, P. H. 1995. Adaptive phenotypic plasticity: Consensus and controversy. *Trends Ecol. Evol*., vol. 10, p. 212-217.

WOLTER, B. F. – ELLIS, M. – DEDECKER, J. M. – CURTIS, S. E. – HOLLIS, G. R. – SHANKS, R. D. – PARR, E. N. – WEBEL, D. M. 2002. Effects of double stocking and weighing frequency on pig performance in wean to finish production systems. *J. Anim. Sci.*, vol. 80, p. 1442-1450.

ZUMBACH B. – MISZTAL, I. – TSURUTA, S. – HOLL, J. – HERRING, W. – LONG, T. 2007. Genetic correlations between two strains of Duroc and crossbreds from differing production environments for slaughter traits *J Anim Sci*., vol. 85, p. 901-908.