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GENETIC PARAMETERS AND GENETIC TRENDS OF GROWTH AND LITTER SIZE TRAITS IN THE WHITE PANNON BREED

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ABSTRACT

The genetic parameters of growth and litter size traits were estimated in the White Pannon breed, selected for growth rate, using a REML procedure applied to a multiple trait animal model. Three traits were analysed : average daily gain between 6 and 10 weeks (ADG), individual weight at 10 weeks (IW10) and litter size at birth (LSB).The genetic parameters were then used to estimate genetic trends between 1992 and 1997, by the BLUP methodology. The data consisted of 28325 animals wheighed and 4042 litters. The heritabilities of ADG, IW10 and LSB were 0.25, 0.20 and 0.06, respectively. ADG was strongly correlated with IW10. The correlation between LSB and growth traits were positive but low. Favourable genetic trends were obtained for ADG (+0.64 g/d per year) and IW10 (+18.5 g per year). The genetic level of LSB has remained constant over the period. Despite some peculiar unfavourable effects corresponding to the summer period, the general trend of year season effect was favourable for both litter size and growth traits.

INTRODUCTION

The efficiency of a selection for growth traits in rabbit has been shown in several studies (ROCHAMBEAU et al. 1989, ESTANY et al. 1992, ROCHAMBEAU et al. 1994). A mass selection for growth rate has been performed in the hungarian White Pannon breed in order to answer the request of the rabbit producers expecting an earlier attainment of slaughter weight. The authors of this selection program have described an effective improvement of average daily gain accompanied with a favourable evolution of litter size after 4 years of selection (SZENDRÕ et al, 1998). Nevertheless, no genetic analyse has been done yet to measure the part of genetic gain in this improvement.
Using data collected from this selection program , the objective of the present study is dual : (1) an estimate of genetic paremeters of growth and litter size traits, using REML procedures with multiple traits animal models. (2) a study of genetic trends of these traits, using BLUP methodology applied to animal models.

MATERIAL AND METHODS

Data

The White Pannon breed was created in 1991 by the cross of New Zealand White and Californian animals. The breeding program was previously described by SZENDRÕ et al. (1998). The selection has been performed since 1992 in a stock of 250 does and 60 bucks, bred in a closed population. Animals were selected according to their performances for growth rate between the 6th and the 10th week of life. Emphasis was also placed on the

number of teats and on the surface of longissimus dorsi of males but no data was available to analyse these traits.
From March 1992 to August 1997, rabbits were individually wheighed at 6 weeks (IW6) and at 10 weeks (IW10). Because of the high variability of the ages at the first weight (from 27 to 56 days), it has been decided to analyse only IW10 and we kept only the data which ages at this weight were ranged from 68 to 73 days. Average daily gain (ADG) has been individually calculated when the weight at 6 weeks occured between 40 and 50 days after the birth and when the lenght of the fattening period was ranged from 21 to 29 days. Else ADG was treated as a missing value. The litter size at birth was also recorded.
The structure of the data analysed is shown in Table 1. Means and phenotypic standard deviations of the traits are presented in table 2.

Statistical model and computing strategies

(Co)variance components were estimated with a restricted maximum-likelihood procedure applied to a multiple trait animal model (VCE 4.2.5 software,NEUMAIER and GROENEVELD, 1998). Breeding values have been estimated, using the BLUP methodology applied to a multivariate animal model, with the PEST package (GROENEVELD and KOVAC, 1990).
Analyses were carried out with all traits at the same time. The averages of the predicted individual values and the estimates of year season effect were regressed on year season to analyse the general trend of these values.
The statistical models defined for both analyses were the following :
Growth traits : fixed effects of year season (23 levels, minimum of 387 data by level), litter size at birth (11 levels : 1-3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and more), age at the 10 weeks weight , random effects of maternal environment and additive genetic value of animals.
reproductive traits : fixed effects of year season of kindling (19 levels, minimum of 53 data by level), parity (4 levels : parity1, parity 2, parite 3, parity 4 and more), random effects of permanent environment (repeatabilities) and additive genetic value of animals.

Table 1. Structure of the data analysed

Litters	4042
Weights at 10 weeks	28325
Average daily gain	27552
number of sires	304
number of dam	1503
Total number of animals in the pedigree file	28940

Table 2. Means and phenotypic Standard deviations (SD) of litter size at birth (LSB), average daily gain (ADG) and wheight at 10 weeks (IW10).

	IW10(g)	ADG(g/d)	LSB
Mean	2248	37.7	8.82
SD	325	8.2	3.10

RESULTS

Genetic parameters

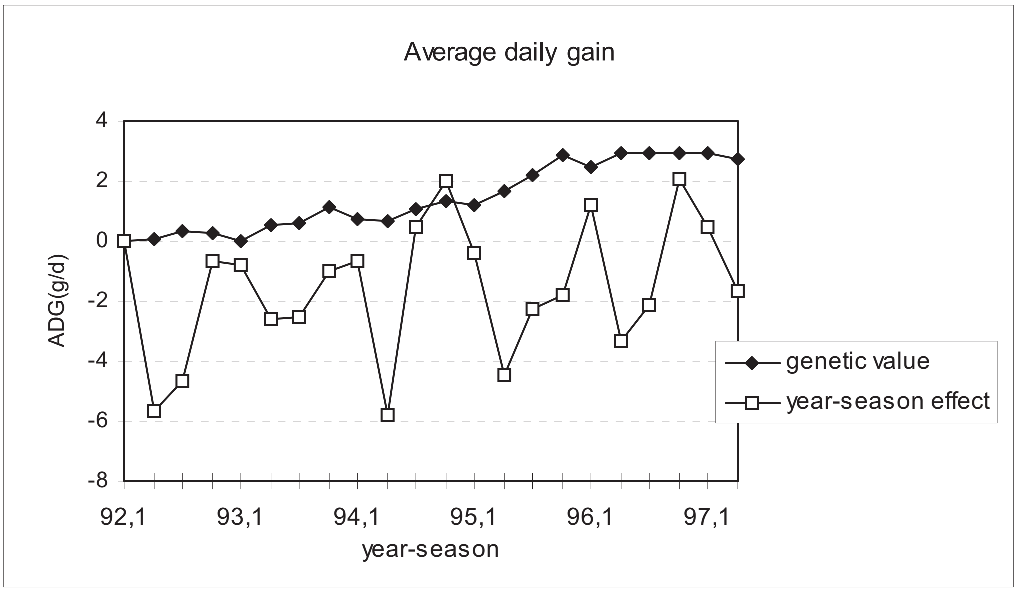
Heritabilities, genetic and phenotypic correlations have been represented in table 3.
Highest heritability values were found for ADG and IW10 (0.25 and 0.20, respectively). Heritability estimate for LSB was low (0.06).
The estimate of the genetic correlation between ADG and IW10 was high (0.74). The phenoypic correlation between these traits was very similar (0.72). LSB was more correlated with ADG (0.18) than with IW10 (0.07). The corresponding phenotypic correlations are also low (0.09 between LSB and IW10 ; 0.06 between LSB and ADG).

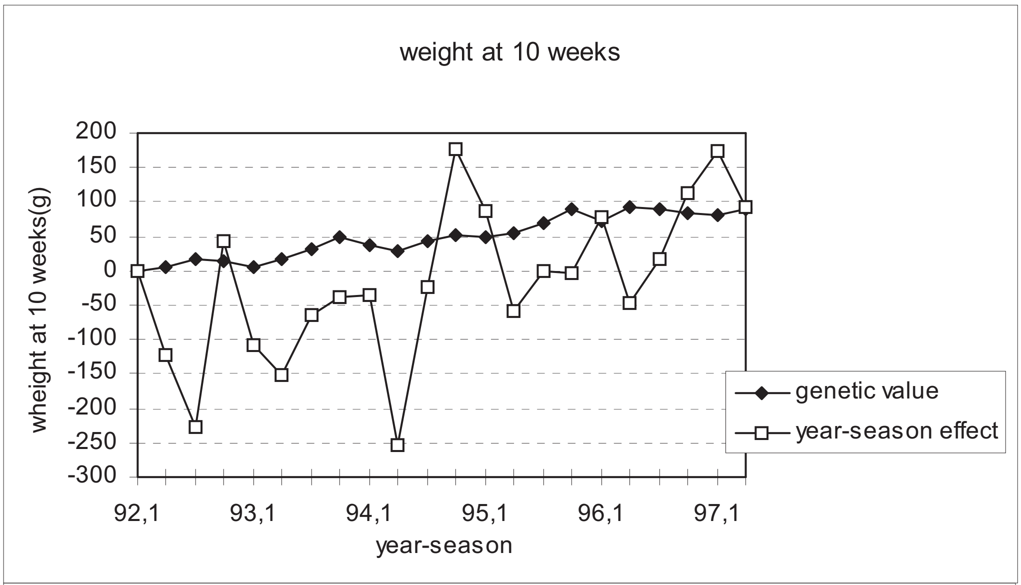
Table 3. Estimates of heritabilities (on the diagonal), genetic correlations (above the diagonal), phenotypic correlations (below the diagonal). Note : standard errors of heritabilities ranged from 0.01 to 0.02 ; standard errors of genetic correlations ranged from 0.02 to 0.12

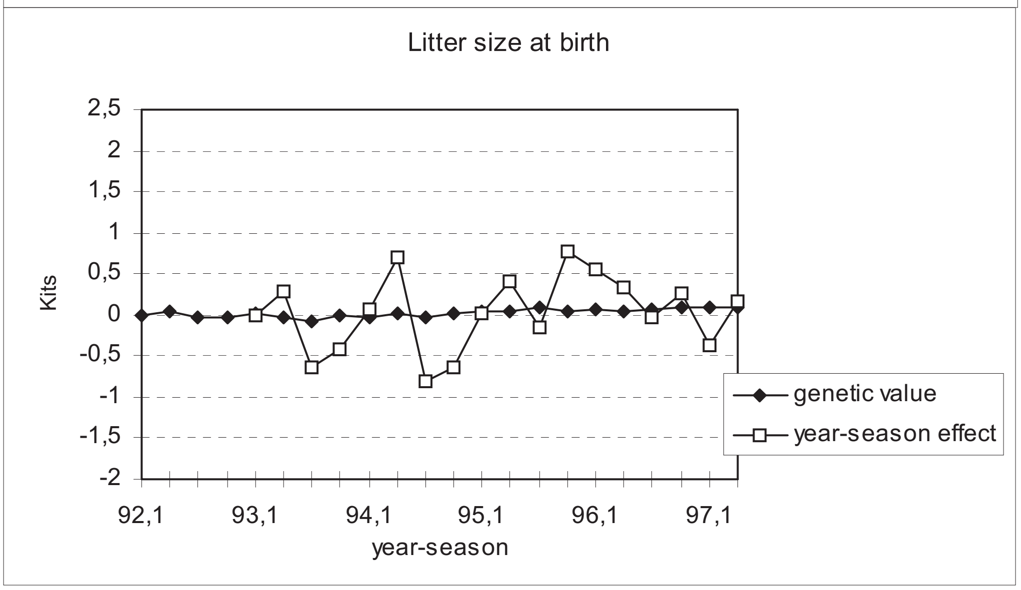
	Weight at 10 weeks	Average daily gain	Litter size at birth
Weight at 10 weeks	**0.20**	0.74	0.07
Average daily gain	0.72	**0.25**	0.18
Litter size at birth	0.09	0.06	**0.06**

Genetic and year season effect trends

Figure 1: genetic and year-season effect trends. Note: First values have been initialized to zero







The genetic and year season effect trends are shown in figure 1. The genetic level of ADG increased significantly between 1993 and 1996 before reaching a plateau. The evolution of IW10 was very similar. The regression coefficients were 0.16 and 4.63 for ADG and IW10, respectively, that is to say the annual genetic gain was + 0.64 g/d and + 18.5 g for ADG and IW10, respectively. There was no significant evolution of LSB during the study period (+ 0.02 kit/year).
The estimates of year-season effects were high in magnitude. Peculiar unfavourable effects for growth and reproductive traits appeared each year at the summer period.
The general trend of year season effect was mostly favourable for growth traits (the regression coefficients were 0.10, 10.28 and 0.02 for ADG, IW10 and LSB, respectively).

DISCUSSION

Genetic parameters

The estimate of heritability of litter size were similar to the values previously estimated in France (ROCHAMBEAU et al. 1994 ; KERDILES 1998). Heritability estimate of ADG was very close to the realized heritability reported by ROCHAMBEAU (1989) (0.25 vs 0.23) and

agreed also with other previous estimates (CAMACHO et al., 1990). Values of heritability for IW10 were consistent, as well, with other literature estimates (CAMACHO et al. 1990 ; ROCHAMBEAU et al. 1994). Nevertheless, GOMEZ et al. (1998) has reported higher values of growth traits heritability (0.34 and 0.37 for ADG and weight at last control, respectively).
The value of genetic correlation between ADG and weight at last control was intermediate between the result obtained by GOMEZ et al. (1998) (0.56) and the result obtained by CAMACHO et al. (1990) (0.92). This result confirm the preponderant part of weight at last control in the growth rate components, as it has been described by CAMACHO et al. (1990).
The favourable genetic relation between growth and litter size at birth was in agreement with genetic correlations estimated by GOMEZ et al. (1998) but ADG was more correlated with LSB in our study (0.18 vs 0.04). Nevertheless, negative realized correlations between ADG and litter size at birth and at weaning have been reported by ROCHAMBEAU et al. (1989). CAMACHO and BASELGA (1990) have calculated realized correlations in four strains. Litter size at weaning and average daily gain were favourably correlated in the two sire lines selected for the growth (0.13 and 0.20) but there were opposite results in the dam lines selected for the litter size (0.42 and -0.65). The authors explained the negative correlation between the two groups of traits in terms of unfavourable maternal effects.

Genetic and year season effect trends

The annual genetic gain of growth traits was significant but lower than the values reported in the literature (ESTANY et al. 1992 ; ROCHAMBEAU et al. 1994 ; LUKEFAHR et al. 1996). Several reasons could be set out to explain this result. Surface of longissimus dorsi on young males has been used as a secondary selection criterion in the last years of the period. Even if the genetic correlation between this trait and growth traits is not strongly unfavourable, the addition of a second selection criterion may have reduced the efficiency of the selection for growth traits in the last years. Thus, the generation length (60 weeks) , which is an important component of the genetic gain, is longer than in other rabbit stock selected for growth traits (ROCHAMBEAU et al., 1994).
The favourable evolution of growth performances presented by SZENDRÕ et al (1998) was so due both to genetic and environmental improvement. The change of nutrient composition of the diet, which occured during the studied period, according to the authors, may have contributed to the improvement of breeding conditions.
The peculiar unfavourable summer effects have been reported by SZENDRÕ et al. (1998). Whitout any climate control in the buildings, temperatures were often over 25 °C in summer and have involved lower feed consumption. The genetic gain did not seem to have been affected by these climate effects.
The very low corretated response of LSB confirm some results of the literature (ROCHAMBEAU 1997 ; GOMEZ 1998). The phenotypic improvement presented by SZENDRÕ (0.5 kit between 1992 and 1996) was so mainly due to the husbandry improvement. Anyway, it must be emphasized that the selection for growth rate has not deteriorated the genetic level of LSB, despite the unfavourable correlated response described in other selection programs.

CONCLUSION

The genetic parameters estimated in the White Pannon stock were very consistent with other values in the literature. The genetic gain estimated by the BLUP methodology was lower than expected. The long generation length and the introduction of secondary selection criteria are certainly responsible for this low value. The genetic level of LSB has not been deteriorated by the selection for growth rate. The genetic trends combined with a favourable evolution of breeding conditions over the period led to a general improvement of both growth and reproductive traits.

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