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GROWTH TRAITS IN SIMPLE CROSSBREEDING AMONG DAM AND SIRE LINES

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ABSTRACT

Twenty-five genetic groups were produced following a diallel-crossbreeding scheme among five lines: three dam and two sire lines belonging to two Spanish Research Institutions (UPV and IRTA). A total of 2773 young rabbits from 525 kindlings were controlled in different seasons. Growth traits were evaluated during the fattening period lasting from five to nine weeks. On average, genetic groups coming from lines selected for growth rate were heavier (+57 g at weaning and 311 g at 60 days), had a faster growth rate (+9 g/d) and a realised higher daily feed intake (+12.9 g/d), improving feed conversion ratio (-0.21), than the groups originated from crosses among lines selected for litter size. Crossbreeding parameters were estimated using the Dickerson model. Maternal genetic and heterosis effects were close to 0 or very low. Direct genetic effects mainly regulated expression of these traits.

Key words: growth, crossbreeding, heterosis, feed efficiency.

INTRODUCTION

The intensive production of meat rabbits is based on a three way-crossbreeding scheme. A first cross involves two different dam lines selected for litter size in order to obtain a crossbred doe taking profit of heterosis in reproductive traits (BRUN and ROUVIER, 1984; BASELGA *et al.*, 2003). The crossbreeding scheme should be completed using as sire a male coming from paternal lines, selected for growth traits (ROCHAMBEAU *et al.*, 1996; LOBERA *et al.*, 2000). This second cross improves the performance of young rabbits during the fattening period.

Sire and dam lines are being selected in two public Spanish organizations executing rabbit breeding programs: UPV and IRTA (GÓMEZ *et al.*, 1999). Some of these lines (three dam and two sire lines) participated in an experiment whose main objective was to optimize the composition and direction of the two crosses in the aforementioned crossbreeding scheme (ORENGO, 2003). From an economical point of view, post weaning average daily gain, feed intake and feed conversion ratio are the most important growth traits in rabbit production (ARMERO and BLASCO, 1992), but mainly the last one because post weaning feeding accounts for around 40% of total cost (BASELGA and BLASCO, 1989). In order to improve the knowledge about the genetic determination of growth traits, crossbreeding parameters were estimated and the results are presented in this work.

MATERIAL AND METHODS

Animals, Facilities and Handling

The experiment concerned the offspring produced by reciprocally crossing five lines (5x5). Twenty crossbred genetic types and five straight-bred groups were involved. Three of these lines (A, V and P) are being selected for litter size since 1980, 1982 and 1992 respectively. Line A is evaluated using an index (BASELGA *et al.*, 1984), while in the other two a repeatability animal model with BLUP methodology is used (ESTANY *et al.*, 1989; GÓMEZ *et al.*, 1996). R and C sire lines are selected for growth rate in the fattening period since 1980 (ESTANY *et al.*, 1992) and since 1992 (GÓMEZ *et al.*, 2000) respectively.

This experiment was carried out at the experimental farm of the Rabbit Breeding Station of IRTA in Caldes de Montbui (Barcelona, Spain). Initially, animals were reared and bred under commercial farm environmental conditions with a semi intensive reproductive rhythm and in fortnightly batches. First mating of does was about 4.5 months old. Dams were remated 11 days after kindling. Bucks were assigned at random, but avoiding repeated matings and matings of animals with known common grandparents. A sample of 2773 kits born in 525 kindlings was evaluated in different seasons. Young rabbits were weaned and identified at 32 days of age. Each cage contained up to a maximum of eight animals. A total of 360 cages were controlled until marketing age (60 days).

Analyzed traits and Statistical analyses

Individual weights and collective feed consumption were weekly recorded. The collective feed conversion was calculated as the ratio between collective feed intake and collective weight gain. When a young rabbit died within three days from the last control, the record of feed consumption of the cage was not modified. Otherwise, feed intake data were corrected based on the initial live weights and the lapsed days. The analysis concerned the following variables: Individual traits (LW32: liveweight at 32 days (g), LW60: liveweight at 60 days (g), IGR: individual growth rate between 32 and 60 days (g/d)) and collective traits for the whole post-weaning period (CGR: growth rate (g/d), FI: feed intake (g/d) and FCR: feed conversion ratio).

Traits were analyzed with univariate models, pointing out the significance of genetic and non-genetic factors. Mixed models included the following fixed effects: batch (31 levels), parity (3 levels: 1st, 2nd and 3rd or more), genetic type (25 levels) and litter size (7 levels: <6, 6, 7, 8, 9, 10 and >10 kits born alive). Environmental common litter effects and additive genetic values were considered as random effects.

Crossbreeding parameters (and standard errors) were estimated from contrasts between GLM solutions of genetic type effects according to the Dickerson model (DICKERSON, 1969), accounting for the variance-covariance matrix of the estimates. Estimable functions were differences between direct genetics effects, differences between maternal genetic effects and individual heterosis of each combination of two lines.

RESULTS AND DISCUSSION

Descriptive statistics

Table 1 shows the number of records and some descriptive statistics for individual and collective traits. The average growth was modest (around 40 g/d) because this experiment was mainly developed in summery seasons. Regarding genetic groups, the number of individuals in non crossbred groups was higher than in crossbred ones and it should be highlighted the minor contribution of A line, either as paternal or as maternal line.

Non-genetic factors

There was an important effect of the factor batch. The lowest values in liveweights and feed intake were recorded in summery batches because hot seasons had a depressor effect on liveweight at 60 days and growth rate due to lower feed intake (CHIERICATO, 1992; RAMON *et al*., 1996). However, a seasonal pattern was not so evident for feed efficiency. Parity effect was found to be significant in all traits. Young rabbits from first parity attained the lowest figures (weights, growth and intake), as other previous reports (GARCÍA, 2001; PRAYAGA and EADY, 2003). For growth rate, these differences disappeared when weight at weaning was included as covariate in the analysis model. The same was noticed when liveweight at the end of the period was considered as covariate in the analysis of feed intake (ORENGO, 2003). Also, litter size effects constituted a significant source of variation of the studied traits. Excepting feed conversion ratio, as litter size increased, performances got worse: lower weights and growth rates. The results are according with scientific literature concerning litter size effects on rabbit breeding (ESTANY *et al*., 1992; GARCÍA, 2001).

Genetic type effect

Young rabbits mothered by V does were the lightest at 32 and 60 days of age. Average growth of the groups VV, AA and their crosses presented the worst figures for weight at 60 days (1606-1638 g) and daily gain (34.8-35.2 g/d). Lower feed intakes were found in genetic groups involving line A with values less than 100 g/d. On other hand, the C genetic group and the crosses between R and C were the heaviest (1976-2028 g at 60 days) and showed the highest values on daily gain (44.9-46.8 g/d). Also, the last mentioned groups presented a better feed conversion ratio (2.48-2.54) except the AC genetic group. However, this one was estimated with larger error because of the reduced sample size. Similar results have been reported in previous works (MAERTENS, 1992; TORRES *et al*., 1992; FEKI *et al*., 1996; RAMON *et al*.; 1996).

Table 1. Number of records (n), crude mean (μ), standard deviation (σ) and range for liveweight at 32 days (LW32), liveweight at 60 days (LW60), growth rate (IGR and CGR), feed intake (FI) and feed conversion ratio (FCR) during the fattening period.

Data	Individual			Collective		
	LW32 (g)	LW60 (g)	IGR (g/d)	CGR (g/d)	FI (g/d)	FCR
n	2773	2703	2703	360	326	326
μ	691	1810	40.0	40.3	105.8	2.62
σ	153	327	7.9	6.8	20.5	0.22
range	262-1340	770-3005	14.7-67.9	24.2-59	61.5-157.7	2.24-3.78

Direct and maternal genetic effects

Table 2 shows estimates and standard errors of the differences between direct genetics effects and maternal genetic effects of the lines with respect to the V line. There were no significant differences for direct genetic effects in weight at 32 days. It's noteworthy that V line presented an unfavourable maternal genetic effect in comparison with the rest of lines, ranging from 59 to 81 g. This fact could be partly related to the less adult weight of V line (BLASCO and GÓMEZ, 1993). In contrast, differences between direct genetic effects grew up proportionally more than the differences between maternal effects for weight at 60 days. That is in agreement with the information reported by Brun and Ouhayoun (1990).

Considering the sum of both genetic components (direct and maternal) for growth rate (individual or collective), when the differences were significant, they were favourable to sire lines compared to dam lines. Even if significant differences were found for maternal effects, the differences between groups are mainly based on direct genetic effects. So, if sire and dam lines were grouped, the average differences between both were superior to 8 g/d in growth. In feed intake as in feed efficiency there were no significant differences between maternal genetic effects. The discrepancies were based on differences between direct genetic effects. For feed conversion ratio, the average difference between meat and reproductive groups were around -0.2. Therefore, the results showed a negative relationship between growth rate and feed efficiency.

Individual heterosis

Table 3 shows estimates and standard errors of individual heterosis effects. It is important to underline that, almost in all the cases, the effects of heterosis did not statistically differ from zero. But, these values were mainly positive. Significant heterosis effects were found in liveweight traits and growth rate, mainly in AC, AV, CV and PV crosses. When these values were expressed in percentage with respect to the average of the parental lines, they were lower than 6%, as it has been reported in other crossbreeding experiments (BRUN and OUHAYOUN, 1994; MEDELLIN and LUKEFAHR, 2001).

Table 2. Differences between direct genetics effects (g_i-g_v) and between maternal genetic effects (m_i-m_v) for liveweight at 32 days (LW32) and at 60 days (LW60), growth rate (IGR and CGR), feed intake (FI) and feed conversion ratio (FCR).

	Individual			Collective		
	LW32 (g)	**LW60 (g)**	**IGR (g/d)**	**CGR (g/d)**	**FI (g/d)**	**FCR**
g_A-g_V	-21 (36)	-80 (62)	-2 (1.3)	-2 (2.4)	**-10 (4.2)**	-0.16 (0.110)
g_C-g_V	12 (38)	**159 (71)**	**5 (1.5)**	**6 (2.3)**	7 (4.0)	**-0.24 (0.106)**
g_P-g_V	18 (35)	25 (66)	0.6 (1.4)	0.7 (2.1)	-0.6 (3.8)	-0.06 (0.099)
g_R-g_V	19 (36)	**294 (67)**	**10 (1.4)**	**10 (2.0)**	**13 (3.7)**	**-0.29 (0.101)**
m_A-m_V	**69 (24)**	**110 (39)**	1.6 (0.84)	1.3 (1.06)	4.3 (2.7)	0.11 (0.072)
m_C-m_V	**81 (22)**	**155 (42)**	**2.8 (0.90)**	**2.5 (0.91)**	1.9 (2.5)	-0.01 (0.066)
m_P-m_V	**59 (20)**	**112 (38)**	**1.9 (0.81)**	**2.4 (0.79)**	1.5 (2.3)	-0.01 (0.061)
m_R-m_V	**87 (23)**	**126 (41)**	1.6 (0.88)	1.7 (0.90)	0.8 (2.5)	0.03 (0.065)

Estimated values in bold type differ from zero ($P<0.05$)

Table 3. Estimates of direct heterosis (h_{ij}) for liveweight at 32 days (LW32) and at 60 days (LW60), growth rate (IGR and CGR), feed intake (FI) and feed conversion ratio (FCR).

	Individual			Collective		
	LW32 (g)	**LW60 (g)**	**IGR (g/d)**	**CGR (g/d)**	**FI (g/d)**	**FCR**
h_{AC}	-5 (32)	45 (56)	1.7 (1.20)	5.2 (4.07)	3 (6.0)	-0.27 (0.158)
h_{AP}	50 (28)	65 (49)	0.4 (1.07)	0.8 (2.99)	-1 (4.7)	0.05 (0.123)
h_{AC}	**79 (23)**	**91 (41)**	0.6 (0.89)	0.0 (0.97)	0 (2.7)	0.12 (0.069)
h_{AV}	31 (19)	**72 (35)**	**1.6 (0.76)**	**1.4 (0.61)**	2 (2.3)	0.03 (0.060)
h_{CP}	20 (16)	46 (28)	0.9 (0.61)	0.7 (0.45)	1 (1.7)	-0.02 (0.045)
h_{CC}	-3 (19)	- 2 (32)	0.0 (0.70)	0.4 (0.57)	-1 (2.0)	-0.05 (0.053)
h_{CV}	0 (17)	9 (29)	0.5 (0.64)	1.0 (0.49)	0 (1.9)	-0.08 (0.049)
h_{PC}	14 (18)	45 (31)	1.1 (0.68)	**1.3 (0.57)**	2 (1.9)	-0.04 (0.051)
h_{PV}	**30 (14)**	**74 (24)**	**1.7 (0.52)**	**1.8 (0.34)**	1 (1.6)	-0.07 (0.041)
h_{CV}	31 (18)	**64 (30)**	1.3 (0.66)	**1.2 (0.50)**	**5 (1.9)**	0.10 (0.049)

Estimated values in bold type differ from zero ($P<0.05$)

CONCLUSIONS

Growth traits are less dependent on maternal effects than on direct genetic effects. Significant differences in direct genetic effects have been found among sire and dam lines, but not in maternal genetic effects except for live weights. Complementarity and not heterosis is the way to take profit of diversity among these lines when the aim is to improve the performance of young rabbits in the fattening period.

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