GENETIC EVALUATION OF GROWTH TRAITS IN A CROSSBREEDING EXPERIMENT INVOLVING LINE V AND BALADI BLACK RABBITS IN EGYPT

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ABSTRACT

Five genetic groups of rabbits were produced in a crossbreeding experiment involving the Spanish synthetic maternal line V, Egyptian Baladi Black (BB), their first reciprocal crosses (F1) and the second generation (F2) by *inter se* mating of the F1 to evaluate their body weight (BW) and daily weight gain (DG) from weaning (4 weeks) to marketing (12 weeks). A total of 2622 rabbits coming from 24 sires and 114 dams (892 purebred and 1730 crossbred progeny) were controlled to evaluate these genotypes. The study was conducted through two successive years during the first four parities of 114 dams. Statistical model included the fixed effects of animal genotype, year-season, parity order and sex along with the random effect of environmental common litter effects and additive genetic values. Crossbreeding genetic parameters (direct and maternal additive effects, direct and maternal heterosis) were estimated. Highly significant differences ($P<0.001$) were detected for all fixed effects on all traits. Estimates of crossbreeding genetic parameters showed a superiority of line V fryers compared with other genotypes, and Baladi Black had the poorest performance. Estimates of direct heterosis (7 to 11.8%) and maternal heterosis (-0.4 to 7.4%) mainly showed significant positive effects for crossing on growth traits. Estimates of direct and maternal genetic effects showed a positive pattern in favor of line V. The growth traits were significantly affected by direct genetic effects. The maternal effects were less important. These results suggest that applying crossing between line V and Baladi Black rabbits could be an effective breeding method for producing fryers superior in growth traits in Egypt.

Key words: Rabbits, Crossbreeding, Body weight, Growth, Heterosis.

INTRODUCTION

A big interest in the increase of rabbit production in many developing countries to decrease the lack of consumed animal protein for people is noticed (De Paula *et al*., 1996). Egypt has suitable conditions for developing rabbit production through crossbreeding programs. Crossbreeding experiments have a main purpose that is to produce superior crosses for growth traits which are influenced by various genetic and non-genetic factors. Performance comparisons among breeds and their crosses are justified because genetic differences among breeds or strains are large relative to genetic variation within breeds (Dickerson, 1992). These differences are an important potential source of genetic improvement in the efficiency of human food production from rabbits through gains in performance from complementary breed effects and heterosis in crossbreeding. Crossbreeding had been established as a breeding system to exploit the heterosis in animal breeding and it could be fruitfully employed in rabbit breeding for increasing productivity (Reddy *et al.*, 2003). It is also valuable for averaging of breed effects and achieving intermediate values that are superior to opposite extremes (Kinghorn, 2000; Yongjun *et al*., 2006). Positive effects for crossbreeding on growth traits in rabbits have been observed by several investigators (Gad, 1998; Abdel-Ghany *et al*., 2000a; Medellin and Lukefahr, 2001; Orengo *et al*., 2004).

The objective of this study was to evaluate five genotypes of rabbits: the Spanish synthetic maternal line V compared with the Egyptian Baladi Black which was not included in any genetic improvement program, as well as, their F1 and F2 crosses. The studied traits were progeny weight from weaning up to marketing, average daily weight gain at the same period. Estimation of crossbreeding parameters for these traits has been done.

MATERIALS AND METHODS

Animals, facilities and handling

The experimental work was carried out through the period from September 2001 to June 2003 in the experimental farm of the Department of Poultry Production, Faculty of Agriculture, Kafr El-sheikh, Tanta University, Egypt. The experiment concerned the progeny produced from pure line V and Baladi Black rabbits, their first reciprocal crosses (F1) and the second generation (F2) by inter se mating of the F1. Semi intensive reproductive rhythm was conducted; dams were remated 12 days post-partum. Bucks were randomly assigned with restriction of avoiding closely relative matings. First mating of does was at about five months of age.

Analyzed traits and statistical analysis

Individual body weight at 4 (BW4), 8 (BW8) and 12 (BW12) weeks, as well as, daily weight gain (g/d) from 4 to 8 (DG4-8), from 8 to 12 (DG8-12) and from 4 to 12 weeks (DG4-12) were studied. Traits were analyzed using a mixed linear model with the MIXED procedure of SAS 2002 (version 9.0). The model included the fixed effects of: Genotype of the animal (5 levels), parity order (4 levels), year-season (6 levels) and sex (2 levels). Environmental common litter effects and additive genetic values were considered as random effects. The estimated least-squares means were used as input data for the program package CBE, version 4.0 (Wolf, 1996) that was used to estimate the crossbreeding parameters for every group of crossbreds and all analyzed traits. The estimation was carried out by weighed least squares means according to Dickerson model (Dickerson, 1969).

RESULTS AND DISCUSSION

Descriptive statistics

Table 1 shows the number of records and some descriptive statistics for growth traits. The performance was affected by the poor performance of (BB) rabbits as a local non- improved breed. Regarding genetic groups, the number of individuals in crossbred groups (1730) was higher than in purebred ones (892). The minor contribution of (BB) breed should be highlighted.

Table 1: Number of records (N), crude mean (μ), standard deviation (σ) and range for growth traits[1]

Data	Body weight (g)			Daily Gain (g/d)		
	BW4	BW8	BW12	DG4-8	DG8-12	DG4-12
N	2622	2265	2025	2265	2022	2024
μ	407.5	1162.1	1855.1	26.9	24.7	25.8
σ	59.2	190.9	304.0	4.9	4.1	4.5
Range	200-600	550-2000	900-2950	12.5-58.2	11.8-39.8	12.4-42

[1]Growth traits: BW4 = Weight at 4weeks; BW8 = Weight at 8 weeks; BW12 = Weight at 12 weeks; DG4-8= average daily gain from 4 to 8 weeks; DG8-12= Daily gain from 8 to 12 weeks and DG4-12= Daily gain from 4 to 12 weeks

Non-genetic factors

All fixed factors had significant ($P \leq 0.001$) effects on all traits. Parity effect was found to be significant ($P<0.001$) for all traits. Fryers born in the 3rd parity showed the best performance for all traits. Those born in the 4th one had the lightest weight except at weaning (4 weeks) and the smallest daily gain at

all ages. This result is in agreement with most of investigators (Nofal, 1997; Gomez *et al.*, 1999; Abdel-Ghany *et al.*, 2000a) who observed that parity is a significant source of variation of body weight from 4 to 12 weeks of age. The summer season had a great effect on all traits because hot season had a depressor effect on growth due mainly to lower feed intake as indicated by (Chericato, 1992; Ramon *et al.*, 1996; Orengo *et al*,. 2004). Generally, males showed a better performance than females for all traits. This result is confirmed by other authors (Gad, 1998; Toson *et al*., 1999).

Animal genotype effect

Table 2 shows the least squares means (and S.E) for growth traits as affected by different genotypes. There were highly significant differences (P<0.001) for growth traits among genotypes from weaning (4 weeks) up to marketing (12 weeks). Line V progenies showed the best results (body weight and average daily weight gain). The Baladi Black ones were inferior to all genotypes for all traits. F2 progenies followed line V in its performance for BW4 and DG4-8 while, F1 (BB x V) followed line V in the rest of traits. These results are in agreement with findings by Toson *et al*. (1999), Khalil and Afifi (2000), Abdel-Ghany *et al.* (2000a) and Medellin and Lukefahr (2001). These results show the good performance of line V rabbits in growth traits and reflect also the fact that the use of line V in crossbreeding programs with local breeds in Egypt was associated with an improvement in growth performance of the obtained crossbred rabbits.

Table 2: Least squares means (S.E) and significance for genotype for growth traits[1]

Genotype	Body weight (g)			Daily Gain (g/d)		
	BW4	BW8	BW12	DG4-8	DG8-12	DG4-12
V	453.3^{a} (1.6)	1335.9 ^{a} (5.2)	2116.1^{a} (9.2)	31.6^{a} (0.2)	28.1^{a} (0.1)	29.9^{a} (0.2)
BB	261.6^{d} (4.1)	713.3^{d} (13.9)	1130.7^{d} (23.7)	17.1^{d} (0.2)	15.8^{e} (0.2)	16.4^{d} (0.2)
BB x V	398.8^{c} (1.6)	1128.8^{b} (5.2)	1818.5^{b} (8.7)	26.1^{b} (0.1)	24.7^{b} (0.1)	25.5^{b} (0.1)
V x BB	393.4^{c} (3.9)	1084.0^{c} (12.2)	1723.1^{c} (19.9)	25.3^{c} (0.2)	23.4^{d} (0.1)	24.4^{c} (0.1)
F2	403.1^{b} (1.7)	1114.2^{b} (5.7)	1769.6^{b} (9.6)	26.2^{b} (0.1)	24.0^{c} (0.1)	25.1^{b} (0.1)

[1]Growth traits: BW4 = Weight at 4weeks; BW8 = Weight at 8 weeks; BW12 = Weight at 12 weeks; DG4-8= average daily gain from 4 to 8 weeks; DG8-12= Daily gain from 8 to 12 weeks and DG4-12= Daily gain from 4 to 12 weeks
Means with different letters on the same column differ significantly (P<0.001)

Purebred differences

Table 3 shows that purebred differences were found to be significant in favor of line V rabbits compared with BB ones reflecting the superiority of a long-term selected line (V) over the local (BB). In Egypt, Abdel-Ghany *et al*. (2000a) revealed that there was not a general trend of superiority that could be detected in a crossbreeding experiment involving NZW and BB rabbits. They added that NZW rabbits surpassed (significantly at most ages) BB ones for BW at all ages considered, but BB gained in DG at most periods. In Spain, Gomez *et al*. (1999) found that purebred differences between maternal lines (A and V) were not significant for growth traits. The differences between paternal line (R) and the average of maternal lines (A and V) were (+90 g) on weight at 32 days, (+325 g) on weight at 60 days and (+12 g/d) on daily weight gain.

Direct and maternal genetic effects

Direct genetic effects estimates were found to be significant (P<0.01), in favor of line V rabbits compared with BB ones (Table 3). These differences in direct genetic effects for growth traits encourage the utilization of line V rabbits in crossbreeding programs in Egypt. Abdel-Ghany *et al.* (2000a, 2000b) noted that direct genetic effects from crossing NZW with Baladi Red (BR) or Baladi Black (BB) were consistently in favor of BR or BB for postweaning body weights and gains. In this respect, Khalil and Afifi (2000) reported that linear contrasts of direct genetic effects for postweaning body weight were not significant except for body weight at 12 weeks of age, being the value of Gabali breed higher than the New Zealand White ones. In Spain, Gomez *et al.* (1999) with lines V, A and line

R and their all possible crossbreds found that direct genetic effects of line A were higher than in line V for 32-days weight, 60-days weight, and for daily gain from 32-60 days.

Maternal genetic effects were found to be positive and significant, in favour of line V dams, for BW8 and BW12 and only positive for the other traits (Table 3). Gomez *et al*. (1999) reported positive maternal genetic effects for line V over line A for weaning weight, for 60-days weight and for daily weight gain. The present results are in agreement with McNitt and Lukefahr (1996), Gad (1998), Abdel-Ghany *et al*. (2000a). These results show that although the values of maternal genetic effects are lower than those of direct genetic effects; they are still considerable at later ages (10-12 weeks).

Heterotic effects

Direct heterosis estimates were found to be positive and significantly (P<0.01) affecting body weights and average daily gain (Table 3). The present results indicated that progeny weights and daily weight gain are improved by crossbreeding, confirming those of Nofal (1997), Abdel-Ghany *et al*. (2000a), Medellin and Lukefahr (2001) who revealed that superiority of crossbreds over the mean of purebreds for postweaning body weight commonly appears. In this respect, Falconer and Mackay (1996) showed that a cross between two base populations would show heterosis if they differ in the frequency of genes affecting a given trait. Moreover, direct heterosis estimates obtained from this study (7 to 11.8%) are in the range of those obtained by Youssef (1992) and Nofal (1997) and exceed those of Abdel-Ghany *et al*. (2000a) who reported some positive significant heterotic estimates by using Baladi Black as a sire breed with New Zealand White as a dam breed. These results may notify the researchers in Egypt to focus on using BB as a sire breed with another selected foreign breed does to secure appreciable heterotic effects.

Table 3: Crossbreeding genetic parameters (S.E.) for growth traits[1]

	Body weight (g)			Daily gain (g/d)		
	BW4	BW8	BW12	DG4-8	DG8-12	DG4-12
Purebred differences						
V vs. BB	**191.7 (4.4)**	**622.6 (14.8)**	**985.4 (25.4)**	**12.6 (0.6)**	**9.5 (0.9)**	**10.4 (0.7)**
Direct genetic effect						
V vs. BB	**186.3 (6.1)**	**577.8 (19.9)**	**890.0 (33.4)**	**11.8 (0.9)**	**8.4 (1.0)**	**9.6 (1.1)**
%	**52.1**	**56.4**	**54.8**	**48.5**	**38.0**	**41.0**
Maternal genetic effect						
V vs. BB	5.4 (4.2)	**44.8 (13.3)**	**95.4 (16.7)**	0.8 (0.7)	1.0 (0.7)	0.9 (0.8)
%	1.5	**4.4**	**5.9**	3.2	4.6	3.9
Direct heterosis	**38.6 (3.0)**	**81.8 (10.0)**	**147.4 (16.7)**	**1.7 (0.5)**	**2.6 (0.5)**	**2.3 (0.5)**
%	**10.8**	**8.0**	**9.1**	**7.0**	**11.8**	**10.0**
Maternal heterosis	**26.3 (2.3)**	**48.7 (57.2)**	**72.5 (12.7)**	0.3 (0.4)	-0.1 (0.4)	-0.1 (0.5)
%	**7.4**	**4.8**	**4.5**	1.2	-0.5	-0.4

[1]BW4 = Weight at 4weeks; BW8 = Weight at 8 weeks; BW12 = Weight at 12 weeks; DG4-8= average daily gain from 4 to 8 weeks; DG8-12= Daily gain from 8 to 12 weeks and DG4-12= Daily gain from 4 to 12 weeks
Estimated values in bold type differ from zero (P<0.01)

Maternal heterosis estimates were found to be positive and decreases with the age for most of growth traits showing significant effects (P<0.01) for body weights, but negative and non significant for DG8-12 and DG4-12 (Table 3). These results could be attributed to the superiority of crossbred does in mothering ability which is reflected in better performance for growth traits of their progeny. However the estimates of maternal heterosis which are smaller than estimates of direct heterosis for the same traits have been noticed by Nofal (1997). These results could lead to state that maternal heterosis effects are less considerable than direct heterosis for growth traits.

CONCLUSIONS

Positive heterotic estimates encourage the applying of crossbreeding schemes in Egypt. Success could be achieved by combining the adapted local genetic resource (Baladi Black) and the high productive line V in forming a synthetic line that could perform well in Egypt. Moreover, growth traits are more dependent on direct genetic effects than on maternal genetic effects.

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