ADDITIVE AND HETEROTIC COMPONENTS FOR POST-WEANING GROWTH TRAITS IN A CROSSING PROJECT OF V-LINE WITH GABALI RABBITS IN EGYPT

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ABSTRACT

This study was carried out within a four years project that aims to develop a synthetic line (M) between the Sinai Gabali breed (G) and the V-line (V). Data of 6278 young rabbits sired by 242 sires and dam reared by 540 dams coming from six different genetic groups of rabbits (represented by G and V purebreds and their crosses; F1, F2, F3 and M line) were used. The recorded traits were: body weight at weaning (BW4), 8 (BW8) and 12 (BW12) weeks of age, as well as daily gain during intervals of 4-8 (DG4-8) and 8-12 (DG8-12) weeks. Using mixed model methodology, estimable functions of genetic type effects were computed and based on them and the matrix of their variance-covariance errors, the crossbreeding parameters were estimated. It was discussed which parameters could be accurately estimated concluding that no matter six genetic groups were involved, only the difference between G and V for the direct additive effects (D_{G-V}), the individual heterosis (H^I) and the maternal heterosis (H^M) should be considered. The results showed that the differences between G breed and V line were significant for almost all the studied traits, in favor of G breed. Means of F1 rabbits for most traits were significantly higher than the two purebreds. The trend for the average of F2, F3 and M line was to be intermediate between the purebreds and the F1, excepting BW4 and BW8. Positive values of D_{G-V}, the majority of them significant, were obtained on all post-weaning growth traits, confirming the superiority of G over V for growth traits. Percentages of these estimates to the means of the two purebred parents were 5.2, 6.6, 5.3, 11.1 and 21.3% for BW4, BW8, BW12, DG4-8 and DG8-12, respectively, showing an increasing trend as the trait is recorded later. Estimates of H^I were always positive and significant for several of the studied traits. Percentages of H^I were 6.9, 3.6, 5.4, 9.7 and 6.1% for BW4, BW8, BW12 (significant), DG4-8 (significant) and DG8-12, respectively. Percentages of H^M for the same traits are 7.9, 4.8, -0.0, -8.0 and 2.6%, significant for BW4 and DG4-8. The estimates of the direct additive effects; the values and sign of the average of H^I and H^M estimated in this experiment; and the complementarity between G (better in growth) and the V line (better in prolificacy) all of them are indicators of the interest of the cross between Gabali and V line and of their synthetic, the Moshtohor line.

Key words: Purebreds, Synthetic line, Growth, Additive effects, Individual heterosis.

INTRODUCTION

Results of most crossbreeding experiments carried out in Egypt reported that crossing does of New Zealand White breed with bucks of local breeds was generally associated with heterotic effects on growth traits (Afifi *et al.*, 1994 and Khalil *et al.*, 1995). Abou Khadiga (2004) found that direct and maternal additive effects as well as direct heterosis on post-weaning body weight traits were significant (P<0.01) favouring V-line rabbits comparing Baladi Black ones. Khalil *et al.* (2005) showed higher direct and maternal genetic effects of V-line than Saudi Gabali rabbits for most post-weaning growth traits in Saudi Arabia.

Sinai Gabali (G) is an Egyptian rabbit breed well adapted to hot climates (Galal and Khalil 1994). The V-line is a synthetic line originated in 1982 at the Department of Animal Science, Universidad Politécnica, Valencia, Spain, that has been selected for litter size at weaning (Estany *et al*., 1989). The cross between G and V line could be of interest because of the heterosis that can exhibit the crossbreds or for the foundation of a new synthetic line of value to be raised in hot climates. Related to this interest, the objectives of this work were: (1) to compare the performance of G and V line rabbits and their different crossbred groups for post-weaning growth traits, (2) to estimate the crossbreeding parameters for these traits in the cross between G and V line.

MATERIALS AND METHODS

Animals, breeding plan and traits

Animals used in this study were G breed bought from Bedouins living in the north of Sinai and V line rabbits imported by the Faculty of Agriculture in Alexandria from Valencia in 1999. A four-years crossbreeding project was started in March 2003, trying to produce a synthetic line. The procedure began getting the F1 and continued with the production of F2, F3 and successive generations. The rabbits pertaining to a generation posterior to F3 were considered as rabbits of the new synthetic line, hereafter called Moshtohor (M) line. The animals were housed in the rabbitry of the Department of Animal Production, Faculty of Agriculture at Moshtohor, Benha University, Egypt. The type and number of animals involved in this study are shown in Table 1.

Table 1. Number of progeny, sires and dams for genetic group.

Genetic group of the progeny		Group of the sires	Group of the dams	Progeny weaned	Sires	Dams
Sinai Gabali	(G)	G	G	1539	59	147
V Line	(V)	V	V	2294	81	195
GxV	(F1)	G	V	686	24	33
$(GxV)^2$	(F2)	F1	F1	669	21	60
$(GxV)^2$	(F3)	F2	F2	441	27	43
Moshtohor		F3	F3	649	30	62
Total				6278	242	540

Details about the housing, management and feeding of the animals can be found in Iraqi *et al*. (2007). The recorded traits were: body weight at weaning (BW4, in g), at 8 weeks (BW8, in g) and at 12 weeks (BW12, in g). The daily gains between 4-8 weeks (DG4-8, in g/day) , and 8-12 weeks (DG8-12, in g/day) were computed.

Statistical analysis:

Data were analyzed using the following model for each trait:

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z_a u_a} + \mathbf{Z_c u_c} + \mathbf{e}$$

where: **y**= vector of observations; **b**= vector of fixed effects of genetic types (6 levels), sex (2 levels, male and female), parity order (3 levels) and year-season of birth (15 levels); $\mathbf{u_a}$=vector of direct additive genetic effects; $\mathbf{u_c}$= vector of common litter effects; **X**, $\mathbf{Z_a}$ and $\mathbf{Z_c}$ are incidence matrices relating records to fixed effects, additive effects and common litter effects, respectively. A mixed model methodology was used to solve the model and to obtain estimable functions allowing comparisons among the genetic types and estimation of crossbreeding parameters (Groeneveld, 1990; Dickerson, 1992; Table 2). An interesting point is to discuss the crossbreeding parameters that can be estimated given the crossbreeding structure of this experiment. There are six genetic types and this means that five estimable functions of crossbreeding parameters (Table 2) could be estimated, but if it is noted that the same parameters with the same coefficients are involved to explain F3 and M line, the number is reduced to four. Some results show that the recombination losses (R^I) are negligible in many cases (Khalil *et al*., 2005), thus we can eliminate this parameter, reducing the estimation to the differences between direct additive effects (D_{G-V}) and maternal additive effects (M_{G-V}) , the direct heterosis (H^I) and the maternal heterosis (H^M). However the absence of the reciprocal F1 increases the colinearity between direct and maternal effects that makes difficult the separate estimation of both. Consequently we will limit the estimation to D_{G-V}, H^I and H^M.

Table 2. Relationship between estimable genetic type[1] effects (EGT, differences to V line effects) and estimable crossbreeding parameters.

EGT[1]	D_{G-V}	H^I	R^I	M_{G-V}	H^M
G-V	1	0	0	1	0
F1-V	0.5	1	0	0	0
F2-V	0.5	0.5	0.5	0.5	1
F3-V	0.5	0.5	0.5	0.5	0.5
M-V	0.5	0.5	0.5	0.5	0.5

[1] G= Sinai Gabali breed, V= V line, M= Moshtohor line; [2] D_{G-V} = difference between direct additive effects, H^I =direct heterosis, R^I = recombination losses, M_{G-V} = difference between maternal additive effects, H^M =maternal heterosis

RESULTS AND DISCUSSION

Actual means and estimable functions of genetic groups

Actual means of the different genetic types are given in Table 3 and they are expression of the true genetic differences between the types and the peculiar combination of fixed effects affecting the data of the genetic types in this experiment.

Table 3: Actual means of Sinai Gabali breed and V-line and their crosses for post-weaning growth traits[1]

Breed group	BW4		BW8		BW12		DG4-8		DG8-12	
	No.	Mean±SE	No.	Mean±SE	No.	Mean±SE	No.	Mean±SE	No.	Mean±SE
Sinai Gabali	1500	491±4	971	1143±10	584	1795±16	945	23.2±0.3	526	23.8±0.5
V-line	2242	471±4	1622	1102±7	1098	1696±11	1614	21.9±0.2	1088	21.9±0.3
F1	626	484±7	513	1190±13	348	1992±20	472	25.2±0.4	335	29.9±0.6
F2	656	529±7	354	1225±16	225	1917±25	354	23.7±0.5	192	26.6±0.8
F3	419	565±8	254	1185±19	221	1782±25	254	23.4±0.6	205	21.0±0.8
M	622	589±7	470	1193±14	421	1676±18	464	21.2±0.4	412	17.5±0.6

M= Moshtohor line. [1] BWi=Body weight at week i in g, DGi-j= Daily gain between weeks i and j in g/d. Means within column, not sharing any letter are significantly different.

Means of body weights for Gabali and V-line rabbits in the present study fall within the range of reports of Khalil *et al.* (1995), Abd El-Aziz (1998), Gad (1998), Khalil and Afifi, (2000), Youssef (2004) and Abou Khadiga (2004). Table 4 shows contrasts between several genetic type effects, revealing the superiority of the Gabali over the V line. When comparing purebreds with F1, it is noted a trend of increasing the superiority of F1 over the purebreds as the time after weaning is higher. The non significance for BW4 and BW8 could be related with the higher litter size of F1 compared with the purebreds (Iraqi *et al*., 2007) and the consequent effect lowering the weights at weaning and close to weaning. The average of F2, F3 and M line was intermediate between the purebreds and the F1for BW12, DG4-8 and DG8-12 (Table 4). The opposite was for BW4 and BW8 where the best results are for F2, F3 and M line probably due to that in these types the litter size is lower than in F1 and, consequently, lower its effect reducing those weights. An apparent abnormal result refers to BW12 for line (Table 3) that is too low and as a consequence its DG8-12 is also too low. These results were unexpected and we have no explanation for them.

Table 4: Contrasts between genetic type effects+.

Trait[1]	BW4	BW8	BW12	DG4-8	DG8-12
G-V	23±19	74*±27	94*±33	2.5*±0.8	4.9*±1.1
F1 -0.5(G+V)	24±18	42±27	106*±35	2.3*±0.8	2.3±1.3
0.33(F2+F3+M)-0.5(G+V)	67*±17	50*±25	34±29	0.5±0.7	0.7±1.0

+G=Sinai Gabali breed, V= V line, M = Moshtohor line,. [1] BWi=Body weight at week i in g, DGi-j= Daily gain between weeks i and j in g/d. * Contrast significantly different to zero at α=0.05

Table 5: Estimated crossbreeding parameters+.

Trait[1]	BW4	BW8	BW12	DG4-8	DG8-12
D_{G-V}	25±19	74*±26	93*±33	2.5*±0.8	4.9*±1.1
H^I	33±18	40±26	94*±34	2.2*±0.8	1.4±1.2
H^M	38*±18	54±30	-1±38	-1.8*±0.9	0.6±1.4

+D_{G-V} = difference between direct additive effects, H^I =direct heterosis, H^M = maternalt heterosis. [1] BWi=Body weight at week i in g, DGi-j= Daily gain between weeks i and j in g/d. * Parameter significantly different to zero at α=0.05.

Direct additive effects, individual and maternal heterosis

Results in Table 5 show almost the same figures for D_{G-V} as the ones obtained for the contrast G-V, expressing the superiority of the genes of the G breed over the V line for the body weight (BW8 and BW12) and daily gain (DG4-8 and DG8-12) traits. Percentages of these estimates to the means of the two purebred parents were 5.2, 6.6, 5.3, 11.1 and 21.3% for BW4, BW8, BW12, DG4-8 and DG8-12, respectively, showing a increasing trend as the trait is recorded later. Piles *et al*. (2004) reported significant estimates of direct additive effects for live body weight at 60 days, and Khalil and Afifi (1991) reported significant estimates for post-weaning body weight at 12 weeks of age, but non significant for BW4 and BW8. This superiority of the G breed in growth over the V line is interesting because is complementary to the superiority exhibited by the V line in prolificacy (D_{G-V}=-0.65 kits born alive and H^I=0.40, Iraqi *et al*., 2007). This complementarity is beneficial for the cross between G and V line and for the global performance of the synthetic line (Moshtohor line). Results given in Table 5 show that estimates of H^I and H^M were, in general, positive and significant for several of the studied traits. It is of interest to note that for BW4 both heterosis are positive and H^M significant. At first glance, comparing the actual means of F1 with the average of the actual means for purebreds (Table 3), a near zero value could be expected but the information given by F2, F3 and Moshtohor line is, by the contrary, compatible with positive values for H^I. It has been commented before the role of the prolificacy to explain these results. In the present study, the values of H^I(H^M) as percentage of purebreds were 6.9(7.9), 3.6(4.8), 5.4(-0.0), 9.7(-8.0) and 6.1(2.6) for BW4, BW8, BW12, DG4-8 and DG8-12, respectively. Some authors have found lower percentages of H^I that in this experiment as Brun and Rouvier (1998) for weight at weaning (1.5-2%) or Khalil and Afifi (2000) for BW4, BW8 and BW12 (2.2 to –0.6%) and Khalil *et al*. (2005) for body weights (1.3 to 4.5%) and for daily gains (–1.4 to 5.5%) when crossing Gabali Saudi to V-line in Saudi Arabia. Abou Khadiga (2004) has found similar results (8-10.9%) to ours for BW4, BW8 and BW12 weeks when V-line is crossed to Baladi Black rabbits in Egypt. Khalil *et al.* (2005) showed that estimates of H^M were mainly negative and non significant. Their estimates ranged from –5.3 to 0.1% for body weight and from –6.8 to 0.9% for daily gain. Similarly Abou Khadiga (2004) found negative estimates for maternal heterosis (-2.4 to –4.6%). The values and sign of the average of both heterosis found in this experiment are, as the estimates of the direct effects, pointing the interest of the cross between G and V line and of their synthetic, the Moshtohor line.

CONCLUSIONS

The Sinai Gabali breed has higher post-weaning growth traits than V line. Moreover, the values and sign of the average of individual and maternal heterosis; and the complementarity between Sinai Gabali, that is better in growth traits, and the V line, that is better in prolificacy, justify the interest of the cross between Sinai Gabali bred and V line and of their synthetic, the Moshtohor line.

ACKNOWLEDGMENTS

This project was supported by the Spanish Agency of International Co-operation (A.E.C.I.).

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