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HETEROSIS, MATERNAL AND DIRECT ADDITIVE EFFECTS FOR LITTER PERFORMANCE AND POSTWEANING GROWTH IN GABALI RABBITS AND THEIR F_1 CROSSES WITH NEW ZEALAND WHITE

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ABSTRACT

A crossbreeding experiment was carried out involving Gabali (**G**) and New Zealand White (**NZW**) rabbits to estimate direct heterosis ($\mathbf{H}^I$) and direct ($\mathbf{G}^I$) and maternal ($\mathbf{G}^M$) additive effects on some litter traits and postweaning growth. Data on litter traits of 314 litters (litter size and weight at birth and weaning, milk yield at 21 days and total milk yield) and body weight (at 4, 6, 8, 10 and 12 weeks of age) of 1300 weaned rabbits were analyzed using a linear mixed model. $\mathbf{G}^I$ did not significantly affect most litter traits and postweaning growth. **G**-sired litters had similar direct additive effects compared to **NZW**-sired litters and consequently **G** bucks could be used as sires in crossbreeding stratification systems under hot climatic conditions. Crossbred litters (or rabbits) obtained from mating **G** bucks with **NZW** does were generally associated with slight superiority compared to those litters (or rabbits) obtained from the reverse mating. The estimates of $\mathbf{G}^M$ for litter size and weight at birth were significantly in favour of **G**-rabbits, while breed maternity for litter traits measured after kindling was significantly in favour of **NZW** breed. After weaning, growth traits were not significantly affected by $\mathbf{G}^M$. Crossing of **G** rabbits with **NZW** was associated with significant positive estimates of $\mathbf{H}^I$ for litter size and weight at birth and weaning. Slight negative estimates of $\mathbf{H}^I$ were observed for milk yield at 21 days and total milk yield. However, insignificant negative estimates of $\mathbf{H}^I$ were recorded for postweaning growth traits.

INTRODUCTION

Gabali rabbits raised under the Egyptian desert conditions (especially in Sinai) are characterized by a large litter size of 8-12 young and heavy body weight of 3.5-4.5 kg (GALAL and KHALIL, 1994). Crossbreeding between standard breeds and Gabali rabbits raised under the desert conditions is not widely carried out. To date, publications concerning crossbreeding of Gabali rabbits with standard breeds (e.g. New Zealand White) in Egypt are not available. Direct and maternal heterosis, maternal and direct additive effects from crossbreeding experiments including Gabali rabbits were expected to be important especially for post-weaning growth performance (KHALIL, 1996). On the other hand, the New Zealand White breed was found to ibit an outstanding maternal ability as related to behavior, fecundity and lactation JKEFAHR *et al*, 1983ab; OZIMBA and LUKAFAHR, 1991). Results of most crossbreeding eriments carried out in Egypt reported that crossing does of New Zealand White breed with ks of local breeds were generally associated with considerable heterotic effects on most litter growth traits (OUDAH, 1990; EL-DESOKI, 1991; AFIFI *et al*, 1994; KHALIL *et al*, 1995). erefore, this study was conducted to estimate direct (**G^I**) and maternal (**G^M**) additive effects l direct heterosis (**H^I**) for some litter traits and postweaning body weights in a crossbreeding eriment involving New Zealand White and Gabali rabbits.

MATERIAL AND METHODS

crossbreeding experiment was carried out in the Experimental Rabbitry at Moshtohor, gazig University, Egypt (about 27 Km to the north of Cairo) during one production year rted in November 1994.

bbits used in this study represent one desert Egyptian breed (Gabali, **G**) and one exotic breed ew Zealand White, **NZW**). Each buck was allowed to sire all his litters from the same does. e breeding plan permitted the simultaneous production of **G, NZW, G x NZW** and **NZW x** litters in each parity. Matings in this experiment started in November 1994 and stopped in ril 1995. Distribution of breeding does and bucks and number of litters and bunnies born and aned of the four different genetic groups are presented in Table 1.

abbits were raised in a semi-closed rabbitry. Breeding does and bucks were housed separately individual wired-cages.. Does were mated from the same assigned bucks 10 days after each ndling. Young rabbits were weaned at four weeks, ear tagged, sexed and transferred to standard ogeny wire cages equipped with feeding hoppers and drinking nipples. Feeding practices in e rabbitry were described by KHALIL (1994).

ata of litter traits included litter size at birth (**LSB**) and weaning (**LSW**), litter weight at birth WB) and weaning (**LWW**), milk yield at 21 days (**M21**) and total milk yield (**TMY**), while ata of postweaning growth included body weights at 4, 6, 8, 10 and 12 weeks of age (**W4, W6, 8, W10** and **W12**, respectively). Data of litter traits on 314 litters(Table 1) were analyzed using e following mixed model (HARVEY, 1990):

$$_{ijklm} = m + G^i + D^{ij} + A^k + P^l + e^{ijklm} \qquad \textbf{(Model 1)}$$

Where Yijklm is the observation on the ijklmth litter trait (**LSB, LSW, LWB, LWW, M21** and **MY**); m is the overall mean; G_i is the fixed effect of ith breed group; D_{ij} is the random effect f jth doe nested within the ith breed group, A_k is the fixed effect of the kth season of kindling k=1,2); P_l is the fixed effect of lth parity (l=1,....,5); and e_{ijklmn} is the random deviation particular the mth litter, **NID** (0, s^2_e).

Table 1. Number of bucks, does, litters and bunnies distributed in the four breed groups of the study

Genetic group*	Bucks	Does	Litters weaned	Bunnies born	Bunnies weaned
NZWxNZW	15	50	160	1173	850
GxG	8	26	56	348	280
NZWxG	8	25	60	524	360
GxNZW	14	37	98	698	580
Total	55	138	374	2743	2070

*Breed of buck is listed before breed of doe.

Data on 2070 weaned(Table 1) rabbits for postweaning growth traits were analyzed using the following sire model (HARVEY, 1990):

$$\mathbf{Y_{ijklmno} = m + G_i + S_{ij} + A_k + P_l + B_m + C_n + (GB)_{im} + (AP)_{kl} + (AB)_{km} + (AC)_{kn} + (PB)_{lm} + (BC)_{mn} + e_{ijklmno}} \quad \textbf{(Model 2)}$$

Where $Y_{ijklmno}$ is the observation on the ijklmnoth weaned rabbit of the postweaning growth trait **(W4, W6, W8, W10 and W12)**; m is the overall mean, G_i is the fixed effect of the ith breed group, S_{ij} is the random effect of the jth sire nested within the ith breed group (taking the relationship coefficient inverse matrix A^{-1} into consideration), A_k is the fixed effect of the kth season of birth (k=1,2); P_l is the fixed effect of the lth parity (l=1,....,5); B_m is the fixed effect of the mth sex; C_n is the fixed effect of the nth teats number of doe (n= 5,6,... 10); and $e_{ijklmno}$ is the random deviation particular to the oth weaned rabbit, **NID** $(0, s^2_e)$ along with all possible interactions of GB_{im}, AP_{kl}, AB_{km}, AC_{kn}, PB_{lm} and BC_{mn}. Breed group was tested against sire within breed group, while other fixed effects were tested against the remainder.

Crossbreeding effects of direct additive (**G^I**), maternal additive (**G^M**) and direct heterosis (**H^I**) for different litter traits and body weights were estimated according to Dickerson theory (DICKERSON, 1992). Such genetic model permits to derive a selected set of linear contrasts and therefore **G^I**, **G^M** and **H^I** were estimated as:

Direct additive effect:

$$\mathbf{(G^I_{NZW} - G^I_G) = \{[(NZW \times NZW) + (NZW \times G)] - [(G \times G) + (G \times NZW)]\}}$$

Maternal additive effect:

$$\mathbf{(G^M_{NZW} - G^M_G) = [(G \times NZW) - (NZW \times G)]}$$

Direct heterotic effect (units):

$$\mathbf{H^I \text{ in units} = [(NZW \times G + G \times NZW) - (NZW \times NZW + G \times G)]/2}$$

$$\mathbf{H^I (\%) = [(NZW \times G + G \times NZW) - (NZW \times NZW + G \times G)] / [NZW \times NZW + G \times G](100)}$$

G^I and G^M represent direct additive and maternal additive effects, respectively, of the pted genetic group. Each single degree of freedom contrast was tested for significance e Student's t-test.

RESULTS AND DISCUSSION

additive effect (G^I)

ıear contrasts of G^I for most litter and postweaning growth traits were insignificant ; 2&3). Such limited differences in G^I between the two breeds lead to state that **G** could ɪ as a buck-breed in crossbreeding programmes.

had higher estimates of G^I than **G**-for litter weights at birth ($P<0.001$ and at ıg($P<0.10$). High estimates of G^I for litter traits lead to indicate that **NZW** breed could be s a terminal sire breed for litter traits measured at kindling. In France, an experiment showed that Californian-sired litters had higher estimates of G^I for pre-weaning litter than that of **NZW**-sired litters (ROUVIER and BRUN, 1990). A reverse trend was ed in an experiment performed 20 years later (BRUN, 1993). Also, the American study KEFAHR *et al* (1983a) showed that estimates of G^I for pre-weaning litter traits (**LSB, LSW** and **LWW**) were mostly in favour of Californian vs **NZW.** They added that direct ;h Giant effects on pre-weaning litters were positive and high compared with **NZW**.

ıst-weaning growth traits the G^I effects were only significant for the weight at 12 weeks, the value of **G** breed higher thn the one of the **NZW** (Table 3). Such superiority of **G**-abbits in G^I may be an encouraging factor for the rabbit breeder in hot climate countries their native breeds in any crossbreeding stratification system. Estimates of G^I presented le 5 indicate also that G^I at later age (**W12**) was significantly in favour of **G** breed. At later MASOERO *et al* (1985) evidenced such significant G^I in **NZW**, Californian, Burgundy Flemish Giant, Argenté de Champagne and Blue Vienna and their crosses.

rnal additive effect (G^M)

ates of G^M for litter sizes and weights at birth were significant and they were mainly in r of **G** breed (Table 2). After kindling, G^M was significantly in favour of **NZW** breed for **TMY** and **LWW**. This superiority of **NZW** does is attributable to favorable maternal es and an increased levels of milk production compared to **G** does. Crossbreeding iments carried out in Egypt (AFIFI and KHALIL, 1989; OUDAH, 1990; KHALIL *et al*, indicated that estimates of G^M for pre-weaning litter traits were insignificant. However, of the Egyptian findings reported a general trend indicating that litters mothered(*direct maternal additive effects*)by exotic breeds (e.g. **NZW**, Californian, Chinchilla... etc.) ɪed better performance than litters mothered by native breeds (e.g. Giza White and Baladi :s). This evidenced the superiority of exotic breeds in their maternity (in terms of milk

Table 2. Genetic group means (+SE) and estimates of direct additive effect (G^I), maternal additive effect (G^M) and direct heterosis (H^I) of litter traits⁺

Item	LSB	LWB	LSW	LWW	M21	TMY
Genetic group⁺⁺:						
NZWxNZW	6.75±0.22	403±13.7	4.58±0.24	2849±143	2320±92	3482±136
GxG	5.91±0.81	305±50.2	3.49±0.89	2206±524	2235±331	3383±497
NZWxG	8.32±0.82	444±50.4	4.63±0.89	2746±526	1963±326	3111±497
GxNZW	6.65±0.49	389±30.5	4.97±0.54	3099±318	2384±196	3512±300
Significance	*	NS	NS	NS	NS	NS
Direct additive effect:	2.52^{***}	152^{***}	0.8^{NS}	291^{NS}	-336^{NS}	-598^{NS}
Maternal additive effect:	-1.7^{***}	-55^{*}	0.3^{NS}	353^{*}	421^{*}	401^{*}
Heterosis						
H^I	1.2^{***}	62^{**}	0.8^{**}	395^{*}	-104^{NS}	-122^{NS}
H^I (%)	18.3	17.5	18.8	15.6	-4.6	-3.5

⁺⁺Buck-breed listed first NS= Non-significant (P>0.05); *=P<0.05; **=P<0.01; ***=P<0.001.

Table 3. Genetic group means (+SE) and estimates of direct additive effect (G^I), maternal additive effect (G^M) and direct heterosis (H^I) for post-weaning body traits⁺

Item	W4	W6	W8	W10	W12
Genetic group⁺⁺:					
NZWxNZW	591±22	807±23	1065±30	1378±35	1711±36
GxG	587±56	796±62	1084±83	1405±95	1812±87
NZWxG	572±99	820±83	1073±105	1411±114	1718±103
GxNZW	584±51	798±52	1063±66	1364±76	1726±72
Significance	NS	NS	NS	NS	NS
Direct additive effect:	-7.9^{NS}	32.7^{NS}	-8.6^{NS}	19.2^{NS}	-108.4*
Maternal additive effect:	12.2^{NS}	-21.8^{NS}	-10.1^{NS}	-47.1^{NS}	7.8^{NS}
Heterosis:					
H^I	-10.4^{NS}	-7.5^{NS}	-6.5^{NS}	-3.7^{NS}	-39^{NS}
H^I (%)	-1.8	-0.9	-0.6	-0.3	-2.2

⁺⁺ Sire-breed listed first NS= Non-significant (P>0.05); *= P<0.05.

production, maternal behavior and care for young). For most pre-weaning litter traits, maternal superiority of **NZW** breed compared with other standard breeds has been demonstrated in the American studies (e.g. LUKEFAHR *et al*, 1983ab; OZIMBA and LUKAFAHR, 1991) and in the European studies (e.g. PARTRIDGE *et al*, 1981; MASOERO *et al*, 1985; ROUVIER and

.UN, 1990), i.e. using NZW as a dam breed produced high performances in litter size and ight compared to other dam breeds.

ıternal additive effects on all postweaning body weights were insignificant (Table 3). In ypt, AFIFI *et al* (1994) found that postweaning growth of rabbits mothered by **NZW** breed : nearly similar to those rabbits mothered by Baladi Red breed.

rect heterosis (H')

timates of **H'** (calculated in actual units and as percentages) for different traits are given in bles 2&3. The estimates indicated also that crossing between **NZW** and **G** rabbits was usually ;ociated with an existence of heterotic effects on litter size and weight measured at ıdling.and at weaning Estimates of **H'** were significant for **LSB**, **LWB**, **LSW** and **LWW**. fferent crossbreeding experiments carried out in Egypt (AFIFI and EMARA, 1984; AFIFI and HALIL, 1989; KHALIL *et al*, 1995) revealed that heterotic effects for litter size and litter :ight were evidenced.

timates of **H'** for **LSB, LWB, LSW** and **LWW** were positive and ranged from 15.6 to 18.8%. timates for milk production (**M21** and **TMY**) and postweaning body weights (**W4, W6, W8, 10** and **W12**) were negative and low.

CONCLUSIONS

) Since post-kindling litter performances in New Zealand White and Gabali rabbits were not gnificantly different in their breed performance, one may use either of the two breeds as sires. ır rabbits industry, Gabali bucks could be used in terminal crossbreeding system especilly in eas of hot climate.

) Single cross resulted from mating Gabali sires with New Zealand White dams is commended and producers and processors could attained economic benefits of commercial oduction through using of this simple cross.

REFERENCES

FIFI EA., EMARA ME. 1984: Litter weight in local Egyptian and exotic breeds of rabbits and their crosses. *Proceeding 3rd World Rabbit Congress, 4-8 April 1984, Rome, Italy,* **Vol.** *QG1:126-135.*

FIFI EA., KHALIL MH. 1989: Observations on purebred and crossbred litters of Giza White and Grey Giant Flander rabbits in Egypt. *Journal of Applied Rabbit Research,* **12:** 273-277.

AFIFI EA., KHALIL, MH., KHADR AF., YOUSSEF YMK. 1994: Heterosis, maternal and direct effects for postweaning growth traits and carcass performance in rabbit crosses. *Journal of Animal Breeding and Genetics*, **111:** 138-147.

BRUN JM 1993: Parameters du croisement entre 3 souches de lapin et analyse de la reponse a une selection sur la taille de portee: caracteres des portees a la naissance et au sevrabr. *Genet.Sel. Evol.*, **25:** 459-474.

DICKERSON GE. 1992: Manual for evaluation of breeds and crosses of domestic animals. *Food and Agriculture Organization of the United Nations*, Rome, pp 47.

EL-DESOKI AEM. 1991: Study of the effect of some genetic and environmental factors affecting meat yield from some foreign and local breeds of rabbits and their crosses. *M.Sc. Thesis, Faculty of Agriculture, Mansoura University, Egypt.*

GALAL ESE., KHALIL MH. 1994: Development of rabbit industry in Egypt. *Options Mediterraneennes,* **8:** 43-56.

HARVEY WR. 1990: User's Guide for **LSMLMW**. Mixed model least squares and maximum likelihood computer program. PC-Version 2, *Ohio State University, Columbus, USA (Mimeograph).*

KHALIL MH. 1994: Lactational performance of Giza White rabbits and its relation with preweaning litter traits. *Animal Production,* **59:** 141-145.

KHALIL MH. 1996: Breeds of rabbits in desert regions. *Symposium on Development of rabbits in Siani. Siani, 24-27 September 1996, Egypt (In Arabic).*

KHALIL MH., AFIFI EA., YOUSSEF YMK., KHADR, AF. 1995. Heterosis, maternal and direct genetic effects for litter performance and reproductive intervals in rabbit crosses. *World Rabbit Science*, **3(3):** 99-105.

LUKEFAHR S., HOHENBOKEN WD., CHEEKE PR., PATTON, NM. 1983a: Doe reproduction and preweaning litter performance of straightbred and crossbred rabbits. *Journal of Animal Science,* **57(5)**: 1090-1099.

LUKEFAHR S., HOHENBOKEN WD., CHEEKE PR., PATTON NM. 1983B: Characterization of straightbred and crossbred rabbits for milk production and associative traits. *Journal of Animal Science*, **57(5)**: 1100- 1107.

MASOERO G., UBERTALLE A., MAZZOCCO P., BATTAGLINI LM. 1985: Terminal crossing of New Zealand White and Californian Rabbits. (2) Characteristics on the live animal. *Annalidell Istituto Sperimentale per la Zootecnia, **18(2)**: 93-109. (Animal Breeding Abstract, 55, No. 1264).*

OUDAH SM. 1990: Studies on some rabbit breeds and their crosses. *M. Sci. Thesis, Faculty of Agriculture, Mansoura University, Egypt.*

OZIMBA CE., LUKEFAHR SD. 1991: Comparison of rabbit breed types of postweaning litter growth, feed efficiency and survival performance traits. *Journal of Animal Science,* **69:** 3494-3500.

PARTRIDGE GG., FOLEY S., CORRIGALL W. 1981: Reproductive performance in purebred and crossbred commercial rabbits. *Animal Production,* **32:** 325-331.

ROUVIER R., BRUN JM. 1990: Crossbreeding and selection experiments with rabbits: An overview from studies in France about litter traits. *Options Mediterraneennes,* Serie Seminaire, **8:** 29-34.