

ESTIMATION OF CROSSBREEDING EFFECTS FOR DOE TRAITS IN CROSSING OF BAUSCAT AND BALADI RED RABBITS

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ABSTRACT

A crossbreeding experiment was carried out, which involving Baladi Red (BR) and Bauscat (B) rabbits to estimate direct heterosis (H^1), maternal additive (G^M) and direct additive (G^1) effects on doe traits (reproductive and litter traits). The doe traits of 690 litters (NSC, GL, LSB, NBA, LSW, LWB, LWW and LWG) were analyzed using a linear mixed model. Mating group's effect on doe traits were non-significant except NSC ($P \leq 0.05$). Results were in favour of Bauscat rabbit for NBA, LWB, LWW and LWG traits. Crossbreeding between Bauscat and Baladi Red rabbits was associated with significant positive direct heterotic effect on NSC, LWW and LWG traits ($P \leq 0.05$), direct heterosis estimates were positive for all doe traits studied except NSC. Direct additive effect for doe traits were not significant except NSC ($P \leq 0.001$). Linear functions were in the favour of Bauscat-sired rabbits. Maternal additive effect was also not-significant except NSC ($P \leq 0.001$), in favour of local Baladi Red rabbits (as a dam breed) except in the NSC and LWG traits.

Keywords: Egyptian Baladi Red rabbits, crossbreeding, Heterotic effect, maternal additive effect, direct additive effect.

INTRODUCTION

Crossing native Egyptian breeds of rabbits with exotic ones was associated, in most cases, with an improvement in doe reproductive and litter traits (Afifi *et al.*, 1994 and Khalil *et al.*, 1995). Crossbreeding among available breeds (e.g. Baladi, Baladi Red, Baladi Black, Baladi White) has been extensively used in Egypt (Afifi, 1971; El-Qen, 1988; Afifi and Khalil, 1989; El-Desoki, 1991) whereby existing breed differences from a heterotic and complementary standpoint are utilized. Breed differences, direct and maternal heterosis, maternal additive effects and direct additive effect from crossbreeding experiments of rabbits were shown to be important for reproductive performance of doe rabbits. Therefore, this study was conducted to evaluate the importance of heterosis, maternal and direct additive effect on some reproductive and litter traits performances in crossbreeding experiment involving Bauscat and Baladi Red rabbits.

MATERIALS AND METHODS

The experimental work of this study was carried out in the Experimental Rabbit flock maintained by the Department of Animal Production, Faculty of Agriculture, Al-Zahra University in Nasr City, Cairo, Egypt for three consecutive years of starting in September 1998 till October 2001.

The local Egyptian breed of rabbits Baladi Red, (BR) and Bauscat, (B) as exotic breed were used in the present study. According to the breeding plan, the does were mated with bucks of other breed, bucks were assigned at random to does with a restriction to avoid full-sib, half-sib and parent offspring matings. Each buck was allowed to be sire of all litters given by 3-5 does throughout the experimental period. Therefore the breeding plan permitted simultaneous production of BB, BRBR, $\frac{1}{2}B\frac{1}{2}BR$ and $\frac{1}{2}BR\frac{1}{2}B$ litters. Distribution of breeding does and bucks as well as number of litters are presented in Table1. Culled or dead does and bucks during the experimental period were replaced randomly by their substitutes from the same breed from the original stock.

Table 1. Mating groups and number of bucks, does and litters used in the study.

Mating group		Number of		
Buck	Doe	Buck	Doe	Litters
Bauscat	Bauscat	14	47	203
Baladi Red	Baladi Red	13	44	171
Bauscat	Baladi Red	13	44	174
Baladi Red	Bauscat	14	52	142
Total		54	187	690

Rabbits were raised in a semi-closed rabbitry. Breeding does and bucks were housed separately in individual wired-cages with standard dimensions arranged in double-tier batteries. Cage of each doe was provided with a metal nest box for kindling. Some bucks were mated to 3-4 does of the same breed. Each doe was palpated 10 days thereafter to determine pregnancy. The failed to conceive doe were returned to the same mating buck at the day of test. Weaning were at (28 days after birth), young rabbits were sexed, tattooed and transferred to growing batteries to be housed in groups (3 to 4 individuals) in standard progeny wire cages by Feeding hoppers and drinking nipples were used. The rabbits were fed ad-libitum on commercial pelleted ration, which provide 16.3% crude protein, 13.2% crude fibers and 2.5% fat. Berssem was supplied at midday in winter only, clean water was available all time. Cages of all animals were cleaned and disinfected before each kindling regularly. Manure was collected daily and removed outside the rabbitry.

Data for doe traits (NSC, GL, LSB, NBA, LSW, LWB, LWW and LWG) were analyzed using the following mixed mathematical model:

$$Y_{iklmnp} = \mu + M_i + S_{ik} + Y_l + Se_m + P_n + (SeY)_{mi} + (PY)_{ni} + e_{iklmnp}$$

Where:

- Y_{iklmnp} = The observation on the $iklmnp^{th}$ doe traits;
- μ = Overall mean, common element to all observations;
- M_i = fixed effect of the i^{th} mating group;
- S_{ik} = random effect of k^{th} sire nested within the fixed effect of the i^{th} mating group and
- Y_l = fixed effect of the l^{th} year of kindling
- Se_m = fixed effect of the m^{th} season of kindling;
- P_n = fixed effect of the n^{th} parity;

$(SeY)_{ml}$ = fixed effect of interaction between the m^{th} season of kindling and l^{th} year of kindling;

$(PY)_{nl}$ = fixed effect of interaction between the n^{th} parity and l^{th} year of kindling and

$e_{ijklmnp}$ = Residual random deviation assumed to be independently randomly distributed, i.e. N.D $(0, \sigma^2e)$.

Genetic model and estimation of crossbreeding effects:

Crossbreeding effects (maternal additive, direct additive and direct heterosis) on different traits were estimated according to the following genetic model such genetic model permits to derive a selected set of linear contrasts (Harvey, 1990).

The following linear contrasts of mating type least-squares means were computed to quantify different attributable due to sire breed, dam breed and direct heterotic effect:

Purebred differences:

$$\{(G^i_B + G^m_B) - (G^i_{BR} + G^m_{BR})\} = (B \times B) - (BR \times BR).$$

Direct heterosis effect:

$$H^i_{B \times BR} = \{(B \times BR + BR \times B) - (B \times B + BR \times BR)\}.$$

Direct additive effect:

$$(G^i_B) = \{[(B \times B) + (B \times BR)] - [(BR \times BR) + (BR \times B)]\}.$$

Maternal additive effect:

$$(G^m_B) = [(B \times BR) - (BR \times B)].$$

Where:-

G^i and G^m represent direct additive and maternal additive effects, respectively, of the subscripted breed (genetic) group. Each single degree of freedom contrast was tested for significance with the Student's t-test.

RESULTS AND DISCUSSION

Mating groups:

Mating groups effect on the doe traits (reproductive and litter traits) are given in tables (2, 3& 4). Number of services per conception (NSC) was affected significantly ($P \leq 0.05$) by mating groups. These results are in agreement with those reported by Youssef (1992). However Gestation length (GL) did not differ significantly among the four mating groups of the present study. Similar findings were observed by Nayera et al, (1999), Khalil and Afifi (2000). However, for all litter traits studied (LSB, NBA, LSW, LWB, LWW and LWG) mating groups had non-significant effect. The same results was observed by Nayera *et al.*, (1999), Khalil and Afifi (2000) and Abd El-Aziz et al (2002), who found that mating-group effect on most doe litter traits studied, were non-significant.

Least squares means of the doe traits of mating groups in tables (2, 3& 4). Showed that B x BR mating gave the lowest means for NSC and the largest size and heaviest weight of litters. These results might indicate assort of heterotic effect.

Table 2. Estimates of mating groups Mean \pm SE, purebred difference, heterosis (H^i), maternal (G^m) and direct additive effects (G^i) on some doe reproductive traits.

Traits	Reproductive traits		
	No.	NSC	GL
Mating groups			
B x B	203	1.5 \pm 0.05	30.0 \pm 0.08
BR x BR	171	1.5 \pm 0.06	31.0 \pm 0.09
B x BR	175	1.3 \pm 0.06	31.2 \pm 0.09
BR x B	185	1.5 \pm 0.06	31.1 \pm 0.08
Significant		*	ns
Purebred difference			
Bauscat us Baladi Red		- 0.006 \pm 0.06 ^{ns}	- 0.045 \pm 0.10 ^{ns}
Heterosis (H^i)			
$H^i_{B \times BR}$	Unit	- 0.109 \pm 0.04 ^{***}	0.129 \pm 0.07 ^{ns}
	Percent	- 7.4 %	0.42 %
Maternal additive effect (G^m_B)		0.1999 \pm 0.06 ^{***}	- 0.174 \pm 0.10 ^{ns}
Direct additive effect (G^i_B)		- 0.205 \pm 0.08 ^{***}	0.128 \pm 0.14 ^{ns}

NSC = Number of services per conception; GL= Gestation length (days).

Table 3. Estimates of litter size traits of mating groups, purebred difference, heterosis (H^i), maternal additive effect (G^m) and direct additive effect (G^i).

Traits	Litter size traits				
	No.	LSB	NBA	No.	LSW
Mating group					
B x B	203	6.2 \pm 0.23	5.9 \pm 0.25	182	4.2 \pm 0.22
BR x BR	171	6.3 \pm 0.24	5.9 \pm 0.25	147	4.3 \pm 0.23
B x BR	175	6.5 \pm 0.24	6.0 \pm 0.26	137	4.6 \pm 0.24
BR x B	185	6.2 \pm 0.23	5.8 \pm 0.25	144	4.4 \pm 0.23
Significant		ns	ns		ns
Purebred difference					
Bauscat us Baladi Red		0.135 \pm 0.23 ^{ns}	0.001 \pm 0.23 ^{ns}		- 0.102 \pm 0.20 ^{ns}
Heterosis (H^i)					
$H^i_{B \times BR}$	Unit	0.10 \pm 0.16 ^{ns}	0.01 \pm 0.17 ^{ns}		0.22 \pm 0.14 ^{ns}
	Percent	1.6 %	0.1 %		5.2 %
Maternal additive effect (G^m_B)		0.28 \pm 0.23 ^{ns}	0.17 \pm 0.24 ^{ns}		- 0.21 \pm 0.21 ^{ns}
Direct additive effect (G^i_B)		0.14 \pm 0.33 ^{ns}	0.18 \pm 0.33 ^{ns}		0.11 \pm 0.29 ^{ns}

LSB= Litter size at birth, NBA= number born alive, LSW= Litter size at weaning.

B = Bauscat rabbits, BR = Baladi Red rabbits.

ns = non- significant.

H^i % = [H^i in unit / (average of B + BR)] x 100.

Purebred differences:

Linear contrasts of Bauscat and Baladi Red rabbits are given in Tables (2, 3& 4). However, the differences between them were non-significant for all doe traits (NSC, GL, LSB, NBA, LSW, LWB, LWW and LWG). Abd El-Aziz (1998), Gad (1998), Nayera *et al.* (1999) and Abd El-Aziz *et al.* (2002) with different breeds, found that the differences between these breeds were non-significant for most traits studied. On the other hand, Youssef (1992), Khalil *et al.* (1995) and Khalil *et al.* (2002) showed that the differences between the different breeds studied were significant for most traits ($P \leq 0.05$, $P \leq 0.01$ or $P \leq 0.001$). Results in Table (2, 3& 4) were in favour of Bauscat rabbit for NBA, LWB, LWW and LWG, while it were in favour of Baladi Red rabbit for NSC, GL, LSB and LSW. In this respect, Youssef (1992) found that the linear contrasts of New Zealand White and Baladi Red were in favour of exotic (NZW) for most traits except preweaning mortality (PWM). However, Abd El-Aziz (1998), Nayera *et al.* (1999) and Abd El-Aziz *et al.* (2002) found that the linear contrasts of New Zealand White and Gabli rabbits were in favour of Gabli rabbits for most traits studied.

Table 4. Estimates of litter weight traits of mating groups, purebred difference, heterosis (H^1), maternal additive effect (G^m) and direct additive effect (G^1)

Mating group	No.	Litter weight traits			
		LWB	LWW	LWG	
B x B	203	Mean \pm SE	No.	Mean \pm SE	Mean \pm SE
BR x BR	171	319.4 \pm 14.17	182	1570.0 \pm 72.13	1251.5 \pm 63.18
B x BR	175	316.9 \pm 14.72	147	1556.3 \pm 75.72	1225.2 \pm 66.82
BR x B	185	351.4 \pm 14.96	137	1695.8 \pm 80.49	1342.5 \pm 71.08
Significant		316.1 \pm 14.27	144	1659.5 \pm 76.67	1331.5 \pm 67.92
Purebred difference		ns		ns	ns
Bauscat us Baladi Red		2.565 \pm 14.15 ^{ns}		13.72 \pm 73.90 ^{ns}	26.27 \pm 69.40 ^{ns}
Heterosis (H^1)					
$H^1_{B \times BR}$	Unit	15.54 \pm 53.90 ^{ns}		114.51 \pm 53.90 ^{ns}	98.69 \pm 50.62 ^{ns}
	Percent	4.9 %		7.3 %	8.0 %
Maternal additive effect (G^m_a)		- 35.22 \pm 14.40 ^{ns}		- 36.30 \pm 78.96 ^{ns}	11.03 \pm 74.16 ^{ns}
Direct additive effect (G^1_a)					
		37.79 \pm 20.25 ^{ns}		50.03 \pm 107.85 ^{ns}	37.89 \pm 101.29 ^{ns}

LWB= Litter weight at birth, LWW= Litter weight at weaning, LGW=pre- weaning litter gain.

B = Bauscat rabbits, BR = Baladi Red rabbits. Ns= non- significant.

H^1 % = [H^1 in unit / (average of B + BR)] x 100.

Heterotic effect (H^1):

Estimates of direct heterosis contrasts (calculated in actual units and as percentages) for different doe traits are presented in Tables (2, 3& 4). These estimates indicate that crossbreeding between Bauscat and Baladi Red rabbits was resulted in significant heterotic effect on NSC ($P < 0.001$) and non-significant effect on GL.

Estimates of direct heterosis effect on litter traits (LWW and LWG) was significant ($P \leq 0.05$), while it was non-significant in (LSB, NBA, LSW and LWB). These estimates showed that the positive direct heterosis for all traits except NSC. These results evidenced the superiority of the crossbred for all traits over the purebred parental breeds, attributed to the presence of inter-breed non-additive genetic effects Afifi (1971). In the same trend the heterotic effects most of litter and reproductive traits were recorded by (Youssef, 1992; Abd el-Aziz, 1998; Gad, 1998). However, crossbreeding seemed that it does not improve NSC, similarly Abd El-Aziz (1998) and Gad (1998), for litter size, (El-Dessoki (1991) and Youssef (1992), for litter weight, Afifi and Emara (1984) and Afifi and Khalil (1989). Results obtained in Table (4) showed that heterotic effects (units or percentages) was generally lower at birth than at weaning for litter weight (15.54 vs.114.51gm). This is expected since maternal and milking ability effects decreased with advance of litter age and consequently the non-additive genetic effects could express themselves later at weaning age more than earlier at kindling. Similar findings were obtained by Afifi and Emara (1984) and Afifi and Khalil (1989).

Direct additive effect (G^i):

Estimates of direct additive effect for doe traits (reproductive and litter traits) were presented in Tables (2, 3 & 4). The linear direct additive effect for all doe traits were not significant except NSC ($P \leq 0.001$). Thus, the contribution of buck breed effect in the inheritance of doe traits was little. Nayera *et al.*, 1999; Khalil and Afifi, 2000; Abd El-Aziz *et al.*, 2002 and Khalil *et al.*, 2002) found non-significant breed-of-buck effect on most doe traits.

In general, the Bauscat-sired mating groups produced litters with larger size (LSB and NBA), heavier litter weight (LWB and LWW) as compared to BR-sired group. Thus, the trend of most doe traits was insignificantly in favour of Bauscat- sired rabbits. In this respect, Youssef (1992) reported that direct genetic effects on litter traits at birth was in favour of NZW but not Baladi Red and the reverse was true at weaning. Also, Garcia *et al.* (1982 a & b) found that direct sire effects on litter traits at birth (LSB) for NZW-sired rabbits were remarkable than at weaning (LSW and LWW). In the same time, Rouvier (1979) found negative direct paternity effects of number born and weaned in NZW sired litters, while the corresponding positive estimates were observed in Californians

Maternal additive effect:

Maternal additive effect presented in Tables (2, 3 & 4) on all doe traits (reproductive and litter traits) were non-significant except NSC, LWB ($P \leq 0.001$). Results of literature by El-Dessoki (1991) with New Zealand White, Californian and local Baladi rabbits reported a non-significant source of variation in gestation length. Abd El-Aziz (1998) and Nayera *et al.* (1999) non-significant source of variation in NSC and GL, while Youssef (1992) significant ($P \leq 0.05$) in gestation length. Results of the crossbreeding experiments carried out in Egypt suggested that doe-breed effect was found to be significant ($P \leq 0.05$, $P \leq 0.01$ or $P \leq 0.001$) by El Dessoki (1991) for NBA, LSW and LWW. Afifi and Emara (1984) for LWB, Attalah (1995) for LWB,

Khalil and Afifi (2000) for LSB, LWB and LWW. However, Nayera et al, (1999); and Abd El-Aziz et al, (2002) indicated that maternal breed (additive) effects (expressed as the differences between reciprocal crosses) on litter traits at birth and during the pre-weaning period were not significant.

Mating of B bucks with BR does give larger and heavier litters than those of the reciprocal mating (BR x B) for all doe traits. Although the maternal breed (additive) effects were not significant, the trends of most doe traits were in favour of local Baladi Red rabbits as a doe breed except NSC and LWG. Khalil et al (1995), Nayera et al (1999) and Abd El-Aziz et al (2002) found that BR dammed litters recorded lower performance for NSC compared to B. The present findings might refer to that BR does might be comparable to those of the B ones in their maternity.

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تقدير تأثير الخلط على بعض صفات أنثى الأرناب في خلطة أرناب البوسكات مع البلدي الأحمر

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أجريت هذه الدراسة في مزرعة الأرناب البحثية بكلية الزراعة - جامعة الأزهر بمدينة نصر - مصر خلال ثلاثة سنوات إنتاجية متتالية بدأت في سبتمبر 1998م حتى أكتوبر 2001م استخدم في هذه الدراسة نوعين من الأرناب البوسكات (سلالة أجنبية) و البلدي الأحمر (سلالة محلية) وذلك لدراسة بعض التأثيرات الوراثية لصفات أنثى الأرناب و قياس تأثير كل من الخلط و التأثيرات المضيفة المباشرة و الأمية على بعض الصفات التناسلية و خلفه البطن. كان تأثير مجاميع التلقيح معنويا لصفة عدد التلقيحات اللازمة للإخصاب و غير معنوي لصفة طول فترة الحمل وكانت الفروق بين سللتي البوسكات و البلدي الحمراء غير معنوية و في صالح الأرناب البلدي الحمراء.

كان تأثير مجاميع التلقيح غير معنوي على صفات خلفه البطن و في صالح الأرناب البوسكات بالنسبة لصفات عدد الخلفة المولودة حية في البطن - وزن الخلفة المولودة في البطن - وزن الخلفة المفطومة من البطن - العائد اليومي من الميلاد و حتى الفطام و في صالح الأرناب البلدي الحمراء بالنسبة لصفات عدد الخلفة المولودة في البطن - عدد الخلفة للمفطومة في البطن. تأثير الخلط :

أدى الخلط بين سللتي البوسكات و البلدي الحمراء إلى تحسين عدد التلقيحات اللازمة للإخصاب بتقليل متوسطها بينما لم تتأثر صفة طول فترة الحمل بهذا الخلط طول فترة الحمل أوضحت هذه القياسات وجود قوة خلط مباشرة بالنسبة لصفة طول فترة الحمل. أيضا أدى الخلط بين البوسكات و البلدي الحمراء إلى وجود قوة هجين موجبة بالنسبة لصفات وزن الخلفة المفطومة في البطن - العائد اليومي من الميلاد و حتى الفطام ، بينما لم تتأثر صفات عدد الخلفة المولودة في البطن ، عدد الخلفة المولودة حية في البطن ، عدد الخلفة المفطومة في البطن، وزن الخلفة المولودة في البطن و أوضحت هذه القياسات وجود قوة خلط مباشرة لجميع الصفات المدروسة وقد وجد أن قوة الهجين في صفات خلفه البطن الناتجة من تلقيح ذكور البوسكات بإناث بلدي احمر اكبر من نظيرتها للبطن الناتجة من التلقيح العكسي.

التأثير المباشر المضيف:

لم يكن التأثير المباشر المضيف معنويا وفي صالح ذكور الأرناب البلدي الحمراء على صفة عدد التلقيحات اللازمة للإخصاب. بينما كان غير معنوي وفي صالح ذكور الأرناب البوسكات في صفة طول فترة الحمل، أما بالنسبة لصفة خلفه البطن غير معنوي و كان التأثير المباشر المضيف في صالح ذكور الأرناب البوسكات بالنسبة لهذه الصفات جميعا.

التأثير الأمي المضيف:

كان لمجاميع التلقيح تأثير غير معنوي بالنسبة لصفة طول فترة الحمل وفي صالح سلالة البلدي الحمراء المستخدمة كأم ولكن كان تأثيرها معنوي بالنسبة لصفة عدد التلقيحات اللازمة للإخصاب وفي صالح سلالة البوسكات المستخدمة كأم. كان التأثير الأمي المضيف غير معنوي لمعظم خلفه البطن ولكن كان معنوي بالنسبة لصفة وزن الخلفة المولودة في البطن، بينما ظهر عكس ذلك عند استخدام سلالة البلدي الحمراء كأم فيما عدا صفة العائد اليومي من الميلاد و حتى الفطام.