J. Agric. Sci. Mansoura Univ., 27 (2): 841 - 851, 2002

GENETIC AND ENVIRONMENTAL EFFECTS ON DOE REPRODUCTIVE PERFORMANCE UNDER DESERT CONDITION.

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ABSTRACT

Reproductive performance of 215 does of pure New Zealand White rabbits (NN), pure Californian (CC), two reciprocal crosses (NC& CN), two backcrosses (BC_N and BC_C) and F_2 crossbred were studied. Studied traits were litter size at birth, 7, 14, 21 days of age and at weaning; litter birth weight; average birth weight; gestation length; fertility rate; number of services per conception; parturition interval and mortality rate at 7, 14, 21 days of age and at weaning. Doe genetic group effect was not significant for litter size and mortality rate, except for mortality rate at 7 days of age. The litter weight at birth varied between 407.4±21.6 and 323.6±18.2 g. The crossbred CN does had heavier litter weight at birth than other groups. The NC does crossbred had heavy average birth weight with increased mortality rate when compared with other genetic groups. The litter size at weaning was positively and highly correlated with litter size at birth. The crossbreeds were higher than purebreds for NSC (P<.05). Parturition intervals were similar for NN and CC breeds. The mortality rate was low in spring (warm season) and was high in winter (cold season) indicating that temperature may be important at the phase of young rabbits. Additive effect had a negative effect on the mortality rate at 21 days of age and at weaning. For mortality rate at 7 days direct heterosis had positively significant effect. However, litter size at birth was largely (1.0) rabbits when reared by NN vs CC dams. This difference increased to 1.2 rabbits at weaning.

Key words: reproductive traits, season, rabbit, crossbred, purebred.

INTRODUCTION

Genetic evaluation of doe productivity can be improved by statistical adjustment of significant management and environmental influences. Afifi *et al.* (1976) and Lukefahr *et al.* (1983) indicates that year of kindling, parity, month of kindling are the most important environmental factors affecting doe and reproductive traits in rabbits. Studies on breed evaluation for economic traits under Egyptian condition are limited (Afifi *et al.* 1976, Emara, 1982, and Khalil *et al.* 1987 and 1995). Crossbreeding has been utilized in rabbit breeding to exploit both additive and non-additive genetic variation. Comparisons between crossbred and purebred groups involve genetic contributions (Lukefahr *et al.* 1984). They show economic importance of reproductive traits for rabbit industry.

Objectives of this study were: to examine variation among does within groups, effect of birth season of doe, preweaning litter and reproductive performance, differences in performance traits among purebred and reciprocal crossbred does and differences due to heterosis.

MATERIALS AND METHODS

Reproductive performance of pure New Zealand White rabbits (NN), pure Californian (CC) and the two reciprocal crosses between these breeds, backcrosses (BC_N and BC_C) and F_2 crossbred was studied. Data on 215 does were collected from consecutive production. The rabbits were produced and raised at Maryout Research Station, Desert Research Center. Females and bucks were maintained in individual suspended metal cages with automatic water and feeders. Rabbits were fed *ad libitum* two times daily. Each doe was mated only to one buck. The doe was transferred to the buck's hutch to be mated. Pregnancy was tested by abdominal palpation at the 10^{th} day after mating. Does that failed to conceive were returned to the same mating buck to be remated. They were returned to the same buck every other day thereafter until a conception was observed. All does were mated (0 day) after each parturition. Measurements tested were number of mating per conception (NSC), gestation length (GL) and parturition interval (P.I). Parturition interval was calculated as number of days between successive kindlings of the same doe. Preweaning litters traits were total litter size born and litter and average birth weight.

Litters were weaned at 28 days of age and were removed to growing pens as a group. Within 12 hours after parturition number of kids per litter was counted and the litter were weighed. Litter sizes at birth (LSB) and litter weight at birth (LWB) were recorded. Litter size at 7 days (LS7), 14 days (LS14), 21 days (LS21) and 28 days of age were recorded. Mortality was calculated as a percentage at 7, 14, 21 and 28 days of age related to LSB. Data were subjected to least squares analysis of variance procedures (SAS. 1990) according to the following model:

$$y_{ijkl} = \mu + G_i + S_j + P_k + GS_{ij} + e_{ijkl}$$

where:

y_{ijkl} = Observed

μ = overall mean

G_i = effect of I th genetic group (i=1,..7)

S_j = effect of j^{th} season of year (j=1,..4)

P_k = effect of k^{th} parity of the doe (k=1,..3)

GS_{ij} = interaction between genetic group and season and,

e_{ijkl} = random error.

Crossbreeding effects on litter traits and reproductive performance of doe were estimated according to Dickerson (1992). Specific estimations of additive breed, maternal breed and direct and maternal heterotic effects were derived through contrasts.

Direct additive effect: =1/2(NN+NC)-1/2(CC+CN).

Direct heterosis effect: = ½(CN+NC)-1/2(NN+CC).

Reciprocal crosses differences: = (CN-NC).

Purebred differences = (NN-CC).

RESULTS AND DISCUSSION

Analysis of variance:

Table 1. presents the analysis of variance. The doe genetic group effect was not significant for litter size and mortality rate, except for mortality rate at 7 days of age. The effect of season of birth was significant for all traits, except gestation length and mortality rate during first and second week of age. El-Sayiad *et al.* (1993) reported no significant breed differences in reproductive traits. They added that gestation length and litter sizes at birth and weaning decreased significantly with successive parities. In the present study, parity class of dam was not significant for all traits. The effect of parity was not important for all litter sizes except for mortality rate at 7 d, where it was statistically significant. Khalil and Afifi (1991) found that parity had no effect on preweaning mortality. Interactions among main effects were assumed not to be important.

Table 1: Analysis of variance and significance tests for doe and reproductive traits.

Traits	Genetic group	Season	Parity	Genetic group X Season
Average BW (g)	N.S	N.S	N.S	N.S
Litter Birth Wt. (g)	N.S	***	N.S	N.S
Gestation length days	N.S	N.S	N.S	N.S
Litter size at birth	N.S	†	N.S	N.S
Litter size at 7 days	N.S	**	N.S	N.S
Litter size at 14 days	N.S	***	N.S	†
Litter size at 21 days	N.S	***	N.S	N.S
Litter size at weaning	N.S	***	N.S	N.S
Mortality rate at 7 days	*	N.S	†	N.S
Mortality rate at 14 days	N.S	N.S	N.S	N.S
Mortality rate at 21 days	N.S	*	N.S	N.S
Mortality rate at weaning	N.S	*	N.S	N.S

N.S= not signifcant,, * =P< .05, **= P<.01, ***= P<.001 and †= P<.06-.010

Genetic group comparison for doe:

Least square means, genetic group means and accompanying standard errors are presented in Table 2. The litter size at birth averaged between 5.6±.88 and 8.1±.81 among different genetic groups. Comparisons between purebred groups for the doe litter size at birth, were 7.6 for NN and 6.6 for CC doe rabbits. They did not differ significantly. Afifi and Emara (1987) did not find any difference in the litter size at birth among different genetic groups. Litter weight at birth varied between 407.4±21.6 and 323.6±18.2 g. Crossbred CN does had heavier litter weight at birth than other groups. NC doe crossbred had the heaviest average birth weight that reflected in increased mortality rate when compared with the other genetic groups.

The Californian does had average number of 6.6 pups at birth and reduced to 3.6 young at weaning. The F_2 reduced from 6.7 pups at birth to 4.5 young at weaning. The NN reduced from 7.6 pups at birth to 4.8 young at weaning. These results might be due to poor maternal ability for Californian does during the suckling period. The litter size at weaning was positive and was highly correlated to litter size at birth, as illustrated in Table. 3 (p<.001). The correletions between LSB and LSW (Table 3) are in agreement with the findings of Afifi and Khalil (1989) and Lukefahr (1982). The does that were mothered by New Zealand White had more litter size from birth to weaning than does were mothered by the Californian. The NN is well documented as a breed with outstanding maternal quality, e.g. high fecundity and milk production.

Table 2: Least squares genetic group means and standard errors for doe litter and reproductive performance.

Traits	NN	CC	NC	CN	BC_N	BC_C	F_2
Average BW (g)	54.8 ±2.1	62.0 ±3.7	73.3 ±15.5	55.3 ±1.8	50.0 ±1.8	59.7 ±5.1	56.4 ±1.2
Litter Birth Wt. (g)	368.2 ±17.8	397.1 ±45.4	364.3 ±22.9	407.4 ±21.6	403.5 ±38.1	323.6 ±18.2	358.7 ±15.4
Gestation length days	31.2 ±.36	32.1 ±.1	31.0 ±.3	31.6 ±.25	31.9 ±.28	32.0 ±.31	31.4 ±.16
Litter size at birth	7.6 ±.73	6.6 ±.81	7.0 ±.44	7.6 ±.42	8.1 ±.81	5.6 ±.88	6.7 ±.33
Litter size at 7 days	6.0 ±.29 b	5.9 ±.80 b	5.0 ±.38 b	6.4 ±.37 b	7.8 ±.81a	5.4 ±.86 b	5.8 ±.28 b
Litter size at 14 days	5.4 ±.34 ab	4.6 ±.71 b	4.5 ±.35 b	5.3 ±.37 b	6.8 ±.8 a	4.4 ±.68 b	4.8 ±.29 b
Litter size at 21 days	5.1 ±.36 ab	3.9 ±.67 b	3.8 ±.34 b	4.7 ±.36 ab	6.0 ±.95 a	4.0 ±.65 b	4.5 ±.30 ab
Litter size at weaning	4.8 ±.34 ab	3.6 ±.63 b	3.4 ±.35 b	4.4 ±.38 ab	5.9 ±.96 a	4.0 ±.65 b	4.5 ±.30 ab
Mortality rate at 7 days	12.3 ±2.8 b	10.1 ±3.9 b	27.1 ±4.2 a	15.1 ±3.2 ab	4.2 ±1.7 b	7.1 ±5.6 b	10.5 ±2.2 b
Mortality rate at 14 days	23.0 ±3.6	29.2 ±6.8	35.1 ±4.1	29.5 ±4.0	16.5 ±3.5	19.5 ±10.7	23.3 ±3.6
Mortality rate at 21 days	28.4 ±3.8	38.7 ±8.0	43.4 ±4.5	36.4 ±4.9	26.5 ±7.4	26.5 ±12.2	27.6 ±3.9
Mortality rate at weaning	32.0 ±3.9 ab	42.4 ±8.3 ab	48.7 ±4.9 a	40.4 ±5.2 ab	27.7 ±7.6 ab	26.5 ±12.2 b	27.8 ±3.9 ab

a,b, c: Means within a row no common superscript differ significantly (P<0.05).

Therefore, the NN may be appropriately classified as dam breed resource. Rouvier (1980) reported on a crossbreeding experiment using New Zealand White, Californian and Petite Russe strains of rabbit. The CxN does weaned 0.97 pups per litter more than the mean of the purebred parents whereas NxC does showed no overall improvement over parent strains.

Afifi *et al.* (1976) and Emara (1982) found that differences for breeds of rabbits and their crosses in litter size due to breed groups were not significant at birth and at weaning. Lukefahr *et al.* (1983) repoted significant effect of doe breed on reproductive performance. They observed that NN had better performance than CC does. Season of birth was statistically significant (P<.01) for all traits, except for gestation length, average birth weight and mortality rate from 7 to 14 days of age. It might be due to differences in management weather and genetic composition of the groups among the season.

Table 3: Phenotypic correlation and significance for doe and reproductive traits.

Traits	1	2	3	4	5	6	7	8	9	10	11	12
Average BW (1)	0.0											
Litter Birth Wt. (2)	-.15 *	0.0										
Gestation length (3)	.09 N.S	.07 N.S	0.0									
Litter size at birth (4)	-.18 **	.48 ***	-.43 ***	0.0								
Litter size at 7 days (5)	-.14 *	.66 ***	-.04 N.S	.60 ***	0.0							
Litter size at 14 d (6)	-.08 N.S	.55 ***	-.07 N.S	.50 ***	.81 ***	0.0						
Litter size at 21d (7)	-.05 N.S	.46 ***	-.09 N.S	.41 ***	.68 ***	.89 ***	0.0					
Litter size at weaning (8)	-.03 N.S	.42 ***	-.07 N.S	.37 ***	.63 ***	.83 ***	.96 ***	0.0				
Mortality rate at 7 days (9)	.03 N.S	.11 N.S	-.05 N.S	.18 **	-.38 ***	-.34 ***	-.32 ***	-.32 ***	0.0			
Mortality rate at 14 days (10)	-.02 N.S	.11 N.S	.01 N.S	.15 *	-.20 **	-.57 ***	-.57 ***	-.55 ***	.70 ***	0.0		
Mortality rate at 21 days (11)	-.04 N.S	.11 N.S	.06 N.S	.14 *	-.13 N.S	-.48 ***	-.68 ***	-.68 ***	.57 ***	.86 ***	0.0	
Mortality rate at weaning (12)	-.06 N.S	.12 N.S	.05 N.S	.15 *	-.09 N.S	-.42 ***	-.63 ***	-.71 ***	.54 ***	.82 ***	.92 ***	0.0

* = P<.05, ** = P<.01, *** =P<.001, N.S = not significant

Least squares season means, standard errors and significance are shown in Table. 4. The season was statistically important for mortality at 14, 21 days and at weaning (P<.05). The mortality rate was low in spring (warm season) and was high in winter (cold season) indicating that temperature was important at the young rabbit's life. This result is similar to that observed by Lukefahr *et al.* (1983), Khalil *et al.* (1987), and Ferraz *et al.* (1991). Ahmed (1997) noted that differences in the litters traits that were caused by season of year might be due to variations in climatic condition and milk yield of the doe. Khalil (1993) found that litter traits measured during preweaning stage may be more affected by season than those measured at birth. They might be a reflection of the effect of season of kindling on milk production.

The gestation length was longer in summer than conceiving during other seasons of the year. Afifi and Kadry (1985) reported that does conceiving during September through February had shorter gestation lengths than those conceiving during March and April. Also, Ponce (1978) reported seasonal fluctuation in gestation length of rabbits. However, gestation length was poorly related to the litter traits studied (Table. 3).

Least squares means, genetic group mean and standard errors for the doe litter and the reproductive traits are presented in Table. 5. Purebred group CC had higher NSC than NN breed. Crossbreeds were higher than purebreds for NSC (P<.05). The 11.6 difference in fertility favoring NN over CC does was not significant. Partridge *et al.* (1981) reported low fertility levels of 56 and 60% for NN and CC purebred does. Rouvier *et al.* (1973) observed fertility levels 63.5 and 62.9% for NN and CC does, respectively.

Table 4: Least squares season means and standard error for doe litter and reproductive traits.

Traits	Winter	Spring	Summer	Autumn
Average BW (g)	56.9 ±8.6	60.6 ±8.1	55.4 ±10.8	64.9 ±9.6
Litter Birth Wt. (g)	366.3 ±24.2 ab	398.1 ±22.9 a	297.2 ±30.3 c	325.0 ±26.9 c
Gestation length days	31.2 ±.67 a	31.2 ±.33 a	31.9 ±.43 a	31.5 ±.38 a
Litter size at birth	7.2 ±.67 a	6.8 ±.63 a	5.7 ±.84 ab	5.5 ±.74 b
Litter size at 7 days	5.7 ±.44 ab	6.2 ±.41 a	5.0 ±.55 ab	4.7 ±.48 b
Litter size at 14 days	4.7 ±.44 b	5.5 ±.42 a	3.6 ±4.1 b	4.1 ±.49 b
Litter size at 21 days	4.0 ±.45 b	5.4 ±.42a	3.4 ±.56 b	3.8 ±.50 b
Litter size at weaning	3.8 ±.44 b	5.4 ±.4.2 a	3.4 ±.55 b	3.64 ±.49 b
Mortality rate at 7 days	14.1 ±3.9	12.0 ±3.7	14.6 ±4.9	12.5 ±4.3
Mortality rate at 14 days	28.7 ±5.1 b	21.8 ±4.8 b	36.4 ±6.4 a	23.6 ±5.7 b
Mortality rate at 21 days	37.7 ±5.7 b	23.3 ±5.4 a	38.6 ±7.2 b	30.6 ±6.4 ab
Mortality rate at weaning	40.2 ±6.0 a	23.9 ±5.6 b	39.0 ±7.5 a	34.4 ±6.6 a

a,b,c Means within a row no common superscript differ significantly (P<0.05).

Table 5: Least squares means and standard errors for doe litter, reproductive traits and selected orthogonal contrasts.

Traits	NN	CC	Crossbreeds (F_1)	Purebred contrast (NN-CC)	Heterosis
Number of services per	1.18	1.37	1.76	-.19	.48
conception	±.14 b	±.14 ab	±.13 a	±.21	±.17**
Fertility rate (%)	84.7	73.0	56.8	11.6	-11.8
	±2.1 b	±2.2 ab	±2.1 a	±6.4 *	±5.2 *
Parturition interval (d)	34.3	33.7	36.88	.61	2.9
	±1.6 a	±1.6 a	±1.6 a	±2.2	±1.8

a,b Means within a row no common superscript differ significantly (P<0.05).

Table 6: Estimates of additive, heterosis effects and selected rthogonal contrasts for doe litter and reproductive traits

Traits	Purebred contrast (NN-CC)	Reciprocal contrast (CN-NC)	Direct Additive	Direct Heterosis
Average BW (g)	-8.2±13.7	16.1±10.1	3.96±.55	5.7±8.8
Litter Birth Wt. .(g)	-23.9±40.0	-37.3±29.5	-30.6±24.9	-5.6±25.0
Gestation length (days)	-.83±.55	-.64±.4	-.74±.34 *	-28±.3
Litter size at birth	1.1±1.0	-.38±.7	.34±.6	-.07±.6
Litter size at 7 (days)	.26±.7	-1.2±.5 *	-.47±.4	-.30±.4
Litter size at 14 (days)	.97±.7	-.74±.5	.12±.4	-.12±.4
Litter size at 21 (days)	1.4±.7 *	-.76±.5	.33±.4	-.07±.4
Litter size at weaning	1.49±.7 *	-.84±.5	.32±.4	-.09±.7
Mortality rate at 7 days	2.0±6.4	12.1±4.7 **	7.1±4.0 †	9.5±4.1 *
Mortality rate at 14 days	-6.0±8.3	6.1±6.1	.07±5.2	5.9±5.3
Mortality rate at 21 days	-12.5±9.2	7.2±6.8	-2.7±5.7	3.4±6.0
Mortality rate at weaning (28 days)	-13.0±9.5	7.9±7.0	-2.5±5.9	3.9±6.1

* = P<.05; ** = P<.01; *** = P<.001; † = P< .06-.10

Parturition intervals were similar for NN and CC breeds. Lukefahr *et al.* (1984) found that parturition interval was shorter for crossbred than for purebred dams. The litter weight at 21 days and litters feed intake from 1 to 21 days of age were high for purebred dams. The litter size at birth was small in the terminal crossbreds and was large at weaning (28 days) for NN. Afifi *et al.*(1976), Matheron and Rouvier (1979) and Afifi and Emara (1987) found that crossbreeding was generally associated with increase in litter size at birth and weaning.

Breed and heterotic effects:

Estimates of additive, heterosis effects and contrasts for doe litter and reproductive traits are presented in Table 6. For the first sire breed contrast, comparing litter of NN vs CC paternity revealed a 1.4 rabbit advantage in litter size at 21 days in litter sired by NN bucks. Mortality rate, average birth weight and the litter birth weight were improved in CC-sired litters. Carregal (1980) reported that the litter size at 28 days was comparable for both sire breed litter groups. He found minor differences in the litter traits that were attributable to New Zealand White vs Californian sires. The present finding is the result of high mortality rate in NN sired litters. For mortality rate at 7 days, direct heterosis was positive and had significant effect. Litter size at birth was largely (1.1) rabbits in litters reared by NN vs CC dams and increased to 1.49 rabbits at weaning. That may be due to higher mortality among rabbit of CC maternity. Total mortality in litters of crossbred dams was higher by 3.9% than in litters of purebred dams. The CN does also had higher mortality rate at 7 days than NC does. May and Simpson (1975) reported that kids up to 12 days of age remained solely dependent on their mothers milk until they were weaned. The mothers milk provided main supply of nutrients, (Lukefahr *et al.* 1983). No statistically significant differences were recorded for the mortality traits between the litters of CN and NC crosbred dams. They were infavor of maternal environment that was provided by CN dams.

The linear contrast of direct additive effect for all litter and reproductive performance were not significant, except for gestation length that was significant (P<.05). Additive effect had negative effect on mortality rate at 21 days and at weaning. Rouvier and Brun (1990) reported that Californian sired litters had higher direct genetic effect on preweaning litter traits than that of New Zealand White sired litters.

CONCLUSION

Selection of existing dam breeds for reproductive traits and litter size could be a feasible approach to increase production in commercial rabbit industry. Another potential genetic approach would be developing crossbred doe stock to utilize possible maternal heterosis for reproductive performance.

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J. Agric. Sci. Mansoura Univ., 27 (2), February, 2002

تأثير العوامل الوراثية و البيئية على الصفات التناسلية فى أمهات الأرانــب تحـت ظروف الصحراء

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في هذه الدراسة استخدم فيها عدد ٢١٥ أما من الأرانب النيوزيلندي الأبيــضNN و كاليفورنيا CC كخطوط آباء و الجيل الأول بخطيه NC, CN و الخليط العكســي مــع الآبــاء BCC , BCN و الجيل الثاني F_2. تم دراسة تأثير بعض العوامل المؤثــرة علــى الصفــات التناسلية و صفات الام تحت ظروف الصحراء مثل ترتيب البطن و النوع الوراثى و موسم الولادة . و الصفات التي اخذ ت لدراستها هي: حجم البطن لكل أم عند الميلاد و عند ٧ أيــام و ١٤و ٢١ يوم و عند الميلاد. كذلك متوسط وزن البطن عند الميلاد لكل أم , وزن البطن لكــل ام. كمــا تــم حساب طول فترة الحمل و الفترة بين ولادتين و نسبة الخصوبة. كما تم حساب نسبة النفوق عنــد عمر ٧ و ١٤و ٢١ يوما و عند الفطام. وجد أن التأثير الوراثي الناتج عــن اختــلاف المجــاميع الوراثية غير معنوي فى جميع الصفات المدروسة باستثناء نسبة النفوق عند عمر ٧ أيام من العمر. ووجد أن الاختلافات بين وزن البطن داخل المجاميع الوراثية يــتراوح بيــن ٤٠٧,٤ و ٣٢٣,٦ جرام . كما لوحظ أن الخليط CN كان أثقل في وزن البطن عند الميــلاد بالمقارنــة بالمجــاميع الأخرى . بينما NC الأمهات الخليطة كانت اثقل لمتوسط الوزن عند الميلاد مع زيادة نسبة النفوق لهذه المجموعة عند المقارنة مع المجاميع الأخرى. حجم البطن عند الفطام كان ذو ارتباط إيجــابي و عالي المعنوية مع حجم البطن عند الميلاد. و كانت الأمهات الخليطة تحتاج لعــدد اكــبر مــن التلقيحات للإخصابNSC وكانت الفروق معنوية على مستوى ٥% .كانت الفترة بيــن ولادتيــن متماثلة في كل من NN , CC . كانت نسبة النفوق اقل في شهر الربيع حيث الدفء و كــانت عالية في شهر الشتاء حيث الطقس بارد . و من هذا نجد أن حياة الأرانب الصغيرة مرتبطة لحــد كبير بدرجة حرارة الطقس لأهميته الشديدة. كما قدر التأثير التجميعي و كان ذا تأثير سلبي علــى نسبة النفوق عند عمر ٢١ يوما و كذلك عند الفطام . و كان لتأثير قوة الهجين على نسبة النفــوق عند ٧ أيام إيجابي و معنوي التأثير. كما أن حجم البطن كان أكبر بحوالي ١,٠ أرنب لكل بطــن عندما كانت الام من النوع النيوزيلندي بالمقارنة عندما تكون الام من النوع كاليفورنيا . كذلــك ذاد حجم البطن عند الفطام بمقدار ١,٢ أرنب لكل بطن.