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DIVERSITY OF REPEATABILITY BETWEEN PARITIES FOR LITTER TRAITS AND REPRODUCTIVE INTERVALS IN DOE RABBITS.

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SUMMARY : An experiment was carried out to determine the genetic variation in litter traits and reproductive intervals between different parities in New Zealand White (NZW) and Californian (CAL) rabbits. Data on 581 litters produced by 163 does mated to 43 bucks of NZW and CAL rabbits were involved. A linear mixed model included the effects of service buck and does within service buck (as random effects) and year-season and parity (as fixed effects) was used for analysing such data. NZW breed had higher litter size, weight and gain along with a lower number of stillbirths and preweaning litter mortality relative to CAL breed. Reproductive intervals and number of services per conception of NZW rabbits were relatively lower than in CAL rabbits. Periods of reproductive intervals were short in both breeds (42-43 days from a kindling to another) and they are one of the encouraging factors for the effective use of these two standard breeds on a large scale of commercial production in Egypt. Phenotypic variation in all litter traits and reproductive intervals for both breeds was high. Year-season affected significantly most reproductive intervals and litter traits studied. Litters kindled in spring generally had the smallest litter size and lightest litter weight and gain along with the shortest reproductive intervals compared to litters kindled in autumn and winter seasons. Reproductive intervals in both breeds had a quadratic relationship with parity. Service buck had little or no effect on litter traits and reproductive intervals. Percentage of variation attributed to the service-buck effect were generally higher in NZW breed than in CAL, while the reverse was observed for doe effect. Repeatabilities across all parities of most litter traits and reproductive intervals in both breeds were low and ranged from 0.0 to 0.21 . Repeatabilities for all traits in NZW were similar to those in CAL. For both breeds, repeatabilities of doe traits for first and second parities were generally slightly higher than for second and third parities.

RESUMÉ :Variations de la répétabilité entre portées des caractéristiques de portée et de l'intervalle entre mise bas chez la lapine.
Une expérimentation a été conduite en vue de déterminer la variation génétique des caractéristiques de portée et de l'intervalle entre mise bas, pour les portées successives chez des lapins Néo-Zélandais Blanc (NZW) et Californiens (CAL). L'étude porte sur 581 portées issues de 163 femelles et 43 mâles, appartenant aux 2 races précitées. L'analyse a été faite en employant un modèle linéaire incluant les effets du mâle et de la femelle intra mâle (3 à 5 femelles par mâle), comme effets aléatoires, et l'effet de saison (5 saisons étudiées sur 2 ans) et du numéro de portée, comme effets fixes. La souche NZW a une taille de portée, un poids et un gain de poids de portée plus élevés que la souche CAL. Elle a aussi une mortinatalité et une mortalité naissance-sevrage plus faible. L'intervalle moyen entre mise bas et le nombre de saillies nécessaires à l'obtention d'un mise bas sont plus faibles pour les NZW que pour les CAL. L'intervalle entre 2 mises bas est aussi relativement bref (42-43 jours) pour les deux génotypes, ce qui est encourageant pour leur emploi en Egypte dans les grands élevages commerciaux. La variabilité phénotypique des caractéristiques de portée et de reproduction, est élevée. La saison de reproduction affecte de manière significative la majorité des paramètres étudiés. Les portées nées au printemps sont de taille réduite ; elles ont un poids et un gain de poids inférieur à celui observé en automne et en hiver (pas de reproduction durant les mois d'été en Egypte). Enfin, l'intervalle entre 2 mises bas le plus court est observé au printemps. Dans les 2 races, une liaison quadratique est observée entre l'intervalle entre 2 mises bas et la parité (n° de portée). Le mâle exerce peu d'effet sur les paramètres étudiés. La part de variabilité due au mâle est plus élevée pour les NZW que pour les CAL ; l'inverse est observé pour les femelles. Pour la majorité des paramètres, la répétabilité d'une portée à l'autre est faible : de 0,00 à 0,21. Elle est comparable pour les 2 races. Enfin, pour chacune des 2 races, la répétabilité des paramètres liés à la femelle pour les 1ère et 2ème portées est généralement légèrement plus élevée que pour la seconde et la troisième portée.

INTRODUCTION

In the last decade, popular meat breeds (New Zealand White and Californian rabbits) were introduced in Egypt, being used in large scale commercial production throughout Egypt. According to the literature, the New Zealand White and Californian breeds exhibit outstanding maternal abilities as related to maternal behaviour, fecundity or fertility, lactation, and preweaning growth and survival (LUKEFAHR *et al.,* 1983ab ; LUKEFAHR *et al.*, 1990 ; YOUSSEF, 1992).

The diversity that exists between New Zealand White and Californian breeds and our local breeds is likely to provide genetic combinations suited to a variety of environment and production systems in Egypt. Genetic information on production traits for these two exotic breeds raised under the Egyptian conditions is very limited. The only available information concerning genetic aspects of these two breeds in Egypt was reported by EL-MAGHAWRY (1990) and AFIFI *et al.* (1992). However, without knowledge of the genetics of these two breeds, planned improvement of meat rabbits in Egypt is limited.

The objectives of the present experiment were to investigate the effect of service buck and doe within service buck affecting litter traits and reproductive intervals of New Zealand White and Californian rabbits raised in Egypt. Repeatabilities for these traits were estimated to better understand the effectiveness of culling practices based on life-time production of doe. A related objective was to analyse litter traits and reproductive intervals to determine if the results support the assumption that doe performance at different parities are repeated records of the same trait.

MATERIAL AND METHODS

The study was carried out at the rabbitry of the Faculty of Agriculture at Moshtohor, Zagazig University, Egypt. The experiment was carried out for two consecutive years started in October 1988.

Breeding plan and data

Two exotic breeds, New Zealand White (NZW) and Californian (CAL), were used in this study. At the beginning of the breeding season (during October), females within each breed were assigned at random into groups ranging from 3 to 5 does depending upon the available numbers. For each group of does, a service buck from the same breed was assigned at random but with the restriction of avoiding full-sib and half-sib and parent-offspring matings. Over the two years of the study, each buck was allowed to produce all his litters from the same females. Therefore, the mating design produced several progeny for each successful sire-dam combination. Breeding females and males were housed separately in individual-wired cages of californian type. Cages were arranged in a windowed-insulated rabbitry. Cages of each doe provided with a metal nest box for kindling and nursing its progeny during the suckling period. Cages and nest boxes were cleaned and desinfected regularly before each kindling. Urine and feces dropped from cages on the floor were cleaned every day in the morning.

The theoretical time between kindling and first service was 10 days. Each doe was transferred to the buck's cage to bred. Hand mating was exercised and each doe was weighted at each mating and palpated 10 days thereafter to determine pregnancy. Does that failed to conceive were returned to the same service buck to be rebred, and were returned to the same buck every other day thereafter until a service was observed. On the 25th day of pregnancy, the nest boxes were supplied with rice straw. After kindling, new born litters were examined and recorded for size and weight within 24 hours. Youngs were weaned five weeks after birth. At weaning, litters were recorded for size and weight and the young rabbits were separated from their dams and they were housed in wires butches. Rabbits of nearly similar age (with a maximum number of 10 individuals) were housed in one hutch.
Rabbits were always fed *ad libitum* and food was offered two times daily. A commercial pelleted ration was provided in the morning and in the afternoon. The composition of that ration was 16.3 % crude protein, 13.2 % crude fiber, 2.5 % fat (digestible energy = 2600 kcal/kg). The ingredients of this ration were 32 % barley, 21 % wheat bran, 10 % soya bean meal (44 % CP), 22 % hay, 6 % berseem straw, 3 % corticated cotton seed meal, 3 % molasses, 1 % limestone, 0.34 % salt, 0.3 % minerals and vitamins and 0.06 % methionine. In winter and early months of spring, berseem (*Trifolium alexandrinum*) was supplied at midday. Fresh clean water was available to rabbits at all time.

Litter traits included : number of services per conception (NSC), litter size at birth (LSB), number born alive (NBA), litter weight at birth (LWB), litter size at weaning (LSW), number of stillbirths (NSB), litter weight at weaning (LWW), preweaning litter gain (PLG), preweaning daily gain (PDG) and preweaning litter mortality (PM). Reproductive interval traits included insemination period (interval from first service to successful mating, IP), days open (period from kindling to next conception, DO) and kindling interval (days between two successive litters, KI). Number of litters in NZW and CAL rabbits were 314 and 267, respectively. Data on 85 and 78 does mated to 22 and 21 bucks were involved for NZW and CAL respectively.

Statistical Analysis

Data of NZW and CAL breeds were analysed separately using the Least-Squares and Maximum Likelihood Mean Weight (LSMLMW) Program of HARVEY (1990). Litter and reproductive interval traits were analysed using the following mixed model :

$$\mathbf{Yijklm} = \boldsymbol{\mu} + \mathbf{Bi} + \mathbf{Dij} + \mathbf{YSk} + \mathbf{Pl} + \mathbf{eijklm},$$

where **Yijklm** = the observation on ijklmth litter; μ = overall mean; **Bi** = random effect of ith service buck; **Dij** = random effect of jth doe nested within ith buck; **YSk** = fixed effect of kth year-season of kindling (k = 5, since no summer kindling was practiced in Egypt); **Pl** = fixed effect of lth parity (l = 5) and **eijklm** = random deviation of mth litter of jth doe and ith buck, assumed to be independently and randomly distributed (0, σ^2e). The absence of records in some subclasses did not permit the inclusion of YSxP interaction. The service buck effect were tested by the doe effect, while the other effects were tested against the remainder.

Estimates of variance and covariance components were computed by LSMLMW (HARVEY, 1990) using mainly the Method 3 procedure of HENDERSON. By equating mean squares of random effects to their expectations, estimates of variance components for bucks (σ^2B), does within buck (σ^2D : B) and remainder (σ^2e) were obtained. Repeatabilities (t) for litter and reproductive interval traits were estimated as :

t = (σ^2B + σ^2D:B)/(σ^2B + σ^2e), where σ^2B and σ^2D:B = the variance components for bucks and does–within–bucks, respectively and σ^2e = the random error unique to each litter. For the purpose of early selection (or culling practices), as well as to check that does performance at different parities are repeated records, data of the first three parities were used to estimate repeatabilities of doe traits in two consecutive parities (i.e. first and second parities or second and third parities) or in non-consecutive ones (i.e., first and third parities). Approximate standard errors for repeatability estimates were computed by the LSMLMW program of HARVEY (1990).

RESULTS AND DISCUSSION

Means and variation of uncorrected records

Means, standard deviations (SD) and coefficients of variation (CV) for different litter and reproductive interval traits in New Zealand White and Californian rabbits are given in Table 1. Overall, these results indicate that NZW breed litters had slightly higher means than CAL litters , i.e. NZW litters are larger in size, weight and gain of litter along with a smaller number of stillbirths and preweaning mortality. In addition, reproductive intervals and number of services per conception of NZW rabbits were relatively lower than in CAL rabbits. Breed averages, as cited in previous Egyptian studies (EL–MAGHAWRY, 1990 ; EL–DESOKI, 1991 ; SEDKI, 1991 ; AFIFI *et al.*, 1992 ; HASSAN, 1993) have indicated that litter performances in NZW does are better than those in CAL does. It is false to say that the number of ova laid by NZW does are always higher than that laid by CAL does ; in some strains the number of ova laid are statistically the same (BRUN *et al.*, 1992 ; BOLET and THEAU–CLEMENT, 1994).

The reviewed results reflect the superiority of NZW does in their postnatal maternal abilities (in terms of milk production, preweaning growth and survival, maternal behaviour, mothering ability, etc...) than CAL does (LUKEFAHR *et al.*, 1983b ; SEDKI, 1991 ; YAMANI *et al.*, 1991). However, means for other litter traits (LSB, NBA, LWB, LSW, LWW, PLG and PM) reported here and those reviewed from literature for NZW and CAL rabbits indicated that rabbits of these two popular breeds as raised in Europe and USA are relatively better than those NZW and CAL rabbits raised in Egypt. Accordingly, the genetic potentials of these two breeds are not completely exploited in Egypt.

Periods of IP, DO and KI obtained here (9.7, 10.4 and 42.2 days for NZW and 12.0, 12.7 and 43.7 days for CAL, respectively) indicated that reproductive intervals are relatively short in both breeds. These results are an encouraging factor for the effective use of these breeds on a large scale of commercial production in Egypt. EL-DESOKI (1991) confirmed this issue by obtaining similar averages of DO and KI for NZW and CAL rabbits raised in Egypt ; estimates of DO and KI were 22.8 and 52.6 days for NZW and 22.8 and 51.4 days for CAL rabbits, respectively.

Table 1 : Means, standard deviations (SD) and coefficients of variations (CV) and determination (R^2) for litter traits and reproductive intervals of New Zealand White and Californian rabbits.

Traits	Symbol	New Zealand White					Californian				
		N	Mean	SD	CV%	R^2	N	Mean	SD	CV%	R^2
Reproductive intervals											
Days open	DO	314	10.4	15.5	138	0.55	267	12.7	18.7	122	0.63
Kindling interval	KI	314	42.2	23.9	56	0.54	267	43.7	19.0	36	0.63
Insemination period	IP	314	9.7	5.4	148	0.54	267	12.0	8.6	128	0.63
Litter traits											
Nbr services/conception	NSC	314	1.7	1.8	95	0.57	267	1.8	2.0	86	0.66
Litter size at birth	LSB	314	7.1	2.3	29	0.51	267	6.7	2.3	33	0.51
Litter weight at birth	LWB	314	448	154	29	0.51	267	438	160	35	0.51
Number born alive	NBA	314	7.0	2.3	30	0.51	267	6.9	2.1	29	0.51
Number of stillbirths	NSB	314	0.16	0.39	154	0.50	267	0.25	0.58	211	0.51
Litter size at weaning	LSW	228	5.3	2.2	37	0.54	184	4.9	2.2	41	0.57
Litter weight at weaning	LWW	228	2935	1225	38	0.54	184	2479	1092	41	0.56
Preweaning litter gain	PLG	228	2442	1183	45	0.54	184	2013	1047	48	0.56
Preweaning daily gain	PDG	228	71.6	35.7	46	0.54	184	58.4	30.3	48	0.55
Preweaning mortality %	PM	314	39.6			0.52	267	49.5			0.56

High phenotypic variation in all litter traits and reproductive intervals for NZW and CAL rabbits were obtained (Table 1). Similar high estimates of CV for litter traits and reproductive intervals in NZW and/or CAL rabbits were observed by AFIFI *et al.* (1992), YOUSSEF (1992) and HASSAN (1993). The estimates also show a general trend indicating that phenotypic variation of litter traits at birth were high and increased thereafter with the advance of the litter's age. Results of EL-MAGHAWRY (1990), LUKEFAHR *et al.* (1990), EL-DESOKI (1991), AFIFI *et al.* (1992) and YOUSSEF (1992) confirmed this observation for NZW and/or CAL rabbits. Perhaps this is because litters between kindling and weaning become more sensitive to the non-genetic maternal effects (e.g., parity, age of doe, litter size at birth, etc...), decreasing thereafter with advancing of litter's age.

Phenotypic variation in IP and DO in both breeds was relatively high compared with traits of size, weight and gain of litter (Table 1). Similarly, YOUSSEF (1992) and KHALIL (1993) reported high variations in DO and KI relative to other litter traits studied. However, large reproductive intervals of doe rabbits in Egypt could be attributed to the variation in management decisions (in terms of postpartum mating, remating schedule, etc...)

Year-Season of kindling

For both breeds, year-season effects were significant for litter traits measured at weaning, while being non-significant for litter traits measured at birth. Litter traits measured during preweaning period may be more affected by season than those litters measured at birth. Perhaps this is a reflection of the effect of season of kindling on milk production (YOUSSEF, 1992 ; KHALIL, 1993). The reproductive intervals (IP, DO and KI) in both breeds were also affected ($P<0.01$) by year-season. However, significant effect of year-season on most litter traits and reproductive intervals suggest that the contribution of year-season in the variance of these traits was of considerable importance. Consequently, litter traits and reproductive performance of NZW and CAL doe rabbits in Egypt appear to be highly season-specific and less well-characterized across seasons (KHALIL, 1993).

Litters kindled in spring generally had the smallest litter size and the lightest litter weight and gain compared to litters kindled in autumn and winter. Opposite to litter traits, reproductive intervals of spring born litter in both breeds recorded the least NSC and the shortest IP, DO and KI relative to autumn or winter born litters. Similarly, YOUSSEF (1992) found that the shortest IP, DO and KI were recorded for litters kindled during spring, while the longest periods were obtained for autumn and winter kindlings. Longer reproductive intervals, for both breeds, during autumn and winter could be attributed to stress of lactation during these months (KHALIL, 1993) as opposed to the litters born during spring which have received less milk.

Parity

ANOVA results indicated that parity had little effect in the variation for most litter traits and reproductive intervals in both breeds. Least-squares means for litter and reproductive interval traits in different parities indicated that the parity effect was inconsistent and varied from one trait to another. Most Egyptian studies have shown inconsistent trends for the effect of parity on litter traits and reproductive intervals (e.g. KHALIL *et al.*, 1987 ; EL-DESOKI, 1991 ; SEDKI, 1991 ; YOUSSEF, 1992). To detect a clear relationship between these traits and parity, a third degree polynomial regression analysis was made. The partial regression coefficients had a quadratic relationship with parity for IP, DO and KI in NZW and CAL. R^2 of polynomial regression analysis for different traits showed that the quadratic effect of parity did not account for as much variation in litter traits as it did for reproductive intervals.

Estimation of variance components

The estimates of variance components (σ^2) and percentages of variation (V%) attributable to the service buck and doe for litter and reproductive interval traits for NZW and CAL rabbits are shown in Table 2. For both breeds, service buck had little or no effect on most litter and reproductive interval traits. Inconsistent trends for the effect of service buck on reproductive performance of doe rabbits have been cited in literature. In this respect, KADRY and AFIFI (1983) reported nonsignificant service buck effect for NSC and LSB in Bouscat rabbits, while KHALIL and MANSOUR (1987) pointed out significant effect for LSW, LWB and LWW in Giza White rabbits.

For both breeds, most percentages of doe component of variation (V %) were lower than 20 %, reflecting the large environmental component of variance associated with doe during kindling and raising a litter to weaning (KHALIL *et al.*, 1987). Other studies shown that the doe contribution was generally low or moderate. Such low or moderate percentages of variation in litter and reproductive interval traits may be a result of the negative covariance between adjacent litters in the two years of the study which was confirmed previously for Giza White rabbits by KHALIL and MANSOUR (1987) and for other breeds by GARCIA *et al.* (1982) and BASELGA *et al.* (1992). This may be due to the imbalances in body reserves of the doe from the first year to the second one

(KHALIL *et al.*, 1987). Another explanation could be that does were not kindled or reared in the same size or weight of litter (BLASCO *et al.*, 1982 ; KHALIL *et al.*, 1987). Breed disparity in terms of genetic variation and (or) permanent effects may be another possible explanation in this concern. However, variation in preweaning litter weight, gain and mortality due to doe effects may be attributed to variation in maternal effects determined by maternal behaviour and milking ability of the doe (RANDI and SCOSSIROLI, 1980 ; LUKEFAHR *et al.*, 1990).

Percentages of variation (V%) attributed to the service buck effect were generally higher in NZW breed than in CAL, while V% due to doe effect in CAL were larger than the corresponding percentages in NZW (Table 2). Therefore, usage of service bucks from NZW breed and does from CAL breed could be more effective in the stratification system of commercial breeding programmes in Egypt. Stress of lactation in NZW breed may be the cause of lower V% for reproductive intervals. However, lactation performance of NZW and CAL does may be responsible for the indirect effect on their female progenies i.e. does of high lactating dams present higher size and weight at the age of her first litter. Also, does born and weaned in large sized litters may kindle fewer kits than those from smaller sized litters and may produce litters whose size would be less than the one from which the dam proceeded (BLASCO *et al.*, 1982). Therefore, selection for increased growth rate or increased mature size of the doe might be associated with an increase in the size and weight of her litter at kindling, i.e. the maternal component should take into account the relationship between growth of doe and its reproductive efficiency (KHALIL *et al.,* 1989).

Table 2 : Estimates of variance component (σ^2) and percentages of variation (V%) due to random effects and repeatability estimates across all parities (t ± SE) for litter traits and reproductive intervals in New Zealand White and Californian rabbits.

	Buck		Doe within buck		Remainder		
Trait	σ^2B	V%	σ^2D	V%	σ^2e	V%	t ± SE
New Zealand White							
NSC	a	0.0	a	0.0	2.6	100	a
LSB	0.326	6.3*	0.410	7.9**	4.442	85.8	0.14 ± 0.05
NBA	0.354	6.9*	0.426	8.4*	4.312	84.7	0.16 ± 0.05
NSB	a	0.0	a	0.0	0.165	100	a
LWB	1579	6.7*	2467	10.5*	19457	82.8	0.17 ± 0.06
LSW	a	0.0	0.77	16.4**	3.93	83.6	0.17 ± 0.07
LWW	31806	2.3	106704	7.6*	1259605	90.1	0.10 ± 0.06
PLG	29878	2.3	79216	6.1*	1185388	91.6	0.09 ± 0.06
PDG	31.3	2.7	53	4.5	1093	92.8	0.07 ± 0.06
PM	60.0	5.3	113	10*	963	84.8	0.15 ± 0.05
IP	a	0.0	10.5	4.9	206	95.1	0.05 ± 0.04
DO	a	0.0	7.9	3.7	206	96.3	0.04 ± 0.04
KI	a	0.0	a	0.0	558	100	a
Californian							
NSC	a	0.0	0.60	19.8***	2.43	80.2	0.20 ± 0.07
LSB	0.021	0.4	0.025	0.5	5.03	99.1	0.01 ± 0.04
NBA	0.067	1.2	a	0.0	5.31	98.8	0.02 ± 0.04
NSB	0.033	9.5**	0.033	9.5*	0.28	81.0	0.19 ± 0.07
LWB	a	0.0	1767	7.0	23435	93.0	0.07 ± 0.05
LSW	a	0.0	1.05	20.3**	4.11	79.7	0.21 ± 0.08
LWW	a	0.0	166622	14.2*	1009393	85.8	0.14 ± 0.08
PLG	a	0.0	124485	11.7*	937376	88.3	0.12 ± 0.08
PDG	a	0.0	95	10.8*	785	89.2	0.11 ± 0.07
PM	a	0.0	216	20.7**	828	79.3	0.21 ± 0.06
IP	a	0.0	51.1	17.7**	238	82.3	0.18 ± 0.06
DO	a	0.0	52.1	18.0**	238	82.0	0.18 ± 0.06
KI	a	0.0	49.3	16.6**	247	83.4	0.17 ± 0.06

a : negative estimate set to zero ; * P<0.05 ; ** P<0.01 ; *** P<0.001.

The absence of positive doe variance components for some litter traits (e.g. NSB and KI in NZW and NBA for CAL rabbits) and the small values observed for others (Table 2), indicate unreliable estimates of variance for these traits. This may suggest that selecting does from dams with better litter traits would not assure genetic response unless corrections were made for maternal environment (KHALIL *et al.*, 1987 ; KHALIL, 1993). Such low or negative estimates may be also due to sampling error in the distribution of the small numbers of does within buck groups.

Repeatability estimates

Repeatabilities across all parities given in Table 2 indicate that repeatability for most litter and reproductive interval traits in both breeds were low. The estimates for litter traits in NZW ranged from 0.0 to 0.17, while they ranged from 0.01 to 0.21 for CAL rabbits. Estimates for all litters traits in NZW rabbits were similar to those estimates for the corresponding traits in CAL (Table 2). High variation in milk production of NZW and CAL breed may be a main cause of reduction in doe component of variance of litter traits and consequently small estimates of repeatability for litter traits may be attained. In general, KHALIL (1993) reported that repeatability estimates for lactation traits were higher than those for litter traits and reproductive intervals, i.e. lactation traits are more repeatable than litter traits and reproductive intervals. LUKEFAHR *et al.* (1983 a, b) reported that the high repeatability for some litter traits in NZW may be an indicative of the considerable additive genetic variation for these characters. However, repeatability estimates in the present study agree generally with the corresponding estimates reported in the literature for NZW and CAL rabbits (ROUVIER *et al.*, 1973 ; GARCIA *et al.*, 1982 ; EL-MAGHAWRY, 1990 ; BASELGA *et al.*, 1992). Across breeds, most reviewed estimates for litter traits and reproductive intervals were low or moderate.

The low estimates of repeatabilities obtained in the present and reviewed studies suggest that there may be little amount of permanent environmental variance influencing these litter and reproductive intervals traits and therefore it is necessary to need several records (several parities) before culling of does on litter traits of single record (KHALIL and MANSOUR, 1987). There are some possible reasons for such low estimates of repeatability. One reason may be sampling error. The second probable cause could be the potential downward bias in variance component estimates that were introduced by the estimation procedure (such as including doe and parity in the same model of analysis). Also, connectedness between records of close relatives (dam–daugther) may be decreased with the increase of parity order and consequently a reduction in doe component of variance (i.e. under estimated repeatability) for litter traits in rabbits will be obtained. It may be due to enlarged seasonal differences and other physiological ones between successive parities. This would be shown from the significant differences in least–square means due to effect of year–season as an environmental aspect and parity as a physiological aspect. Moreover, it could be that a negative non–genetic maternal covariance may have existed among adjacent litters.

Repeatabilites of the first three parities (consecutive two and nonconsecutive two parities) are given in Table 3. For both breeds, repeatabilities of doe traits for first and second parities were generally slightly higher than for second and third parities. Lower estimates of repeatabilities of first two parities may be due to that effects of permanent environment, decreases slightly with advance of age. BASELGA et al. (1992) reported that repeatabilities of litter size at weaning and 77 days for second and third parities were higher than for all parities analyse together.

Table 3 : Repeatabilities and their standard errors (t ± SE) for doe traits in two consecutive parities and nonconsecutive ones in New Zealand White and Californian rabbits

Trait	Parity 1 and 2 NZW	Parity 1 and 2 CAL	Parity 1 and 3 NZW	Parity 1 and 3 CAL	Parity 2 and 3 NZW	Parity 2 and 3 CAL
NSC	0.15 ± 0.09	0.32 ± 0.11	a	0.12 ± 0.12	a	0.08 ± 0.12
LSB	0.17 ± 0.09	0.14 ± 0.09	0.23 ± 0.11	a	0.15 ± 0.11	0.07 ± 0.11
NBA	0.17 ± 0.09	0.17 ± 0.08	0.25 ± 0.11	0.01 ± 0.11	0.16 ± 0.11	a
NSB	0.06 ± 0.08	0.07 ± 0.08	a	0.01 ± 0.07	0.17 ± 0.11	0.03 ± 0.12
LWB	0.10 ± 0.08	0.01 ± 0.07	0.21 ± 0.11	a	0.25 ± 0.11	0.13 ± 0.12
LSW	0.31 ± 0.12	0.37 ± 0.12	0.15 ± 0.18	a	0.25 ± 0.15	a
LWW	0.17 ± 0.11	0.45 ± 0.12	0.10 ± 0.13	a	0.12 ± 0.16	a
PLG	0.07 ± 0.11	0.42 ± 0.12	0.06 ± 0.13	a	0.08 ± 0.16	a
PDG	0.08 ± 0.11	0.36 ± 0.12	0.10 ± 0.13	a	0.15 ± 0.16	a
PM	0.14 ± 0.09	0.31 ± 0.10	0.29 ± 0.11	0.22 ± 0.12	0.06 ± 0.10	0.29 ± 0.12
IP	0.14 ± 0.09	0.26 ± 0.10	a	0.08 ± 0.16	a	0.03 ± 0.11
DO	0.15 ± 0.09	0.17 ± 0.10	a	0.10 ± 0.11	a	0.02 ± 0.11
KI	a	0.17 ± 0.10	a	0.09 ± 0.11	a	0.02 ± 0.11

* Estimates of model R^2 for all traits were greater than 0.50 ; a : negative estimate of buck or doe component of variance set to zero.

The same authors added that heritabilities of the first parity were highest and there was a monotonous trend for values to decrease from first to third parity. However, results of the present study and those reported by BASELGA *et al.* (1192) may suggest that first parity may be better in predicting doe performance than third parity relative to the third parity itself, although single records is not preferable in culling/selection policy.

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