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Mortality rate in purebred commercial rabbits under Egyptian conditions

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SUMMARY - Data on 4354 parturitions from commercial breeds of rabbits (Bauscat, New Zealand White and Californian) were analysed to investigate the effects of sire, doe within sire (as a random effects), season of kindling, parity and litter size at birth (as fixed effects) on stillbirths, mortality to 21 days (M21) and total mortality (TM%). Total losses prior to weaning were approximately 24% in all breeds, largely from stillbirth (Sb%) and subsequent mortality to 21 days (M21%) in the nest. Differences between breeds were not significant in all mortality traits studied. Season of kindling, parity of doe and litter size at birth significantly (P<0.001) affected mortality traits studied. The sire genetic variance ($\sigma^2 s$) and doe within sire ($\sigma^2 d:s$) for mortality traits were low and close to zero in three breeds studied. The residual environment variance ($\sigma^2 e$) was high for stillbirths, M21 and TM%. The repeatability (t) values for Sb, M21 and TM% traits were low. Low heritability for all mortality traits indicates that genetic improvement by selection would be difficult, while improvement the environmental and managemental factors (climate, feed, hygiene ect) might be improve the performance of the young.

Key words: Mortality, genetic variance components and non-genetic. heritability and repeatability.

Introduction

Preweaning mortality is the most important cause of reduction in the net litter crop at weaning, especially of commercial breeds under intensive production. Post mortem surveys of rabbit mortality have concentrated on the weaned and adult rabbits, particularly with respect to the problems of enteritis and coccidiosis (SINKOVICS, 1978 and HINTON, 1979). HUGH-JONES *et al.* (1975) concluded that preweaning mortality is much more detrimental to profitability since later deaths, although individually costly, are much less frequent. Little has been written on the genetic basis of maternal care in the rabbit. To date, little information is available about environment and genetic properties in mortality for commercial rabbit populations reared in tropical and subtropical environments. To calculate genetic parameters it is necessary to know if there are any systematic effect of non-genetic factors so that they can be adjusted. The objectives of this study were to evaluate the non-genetic maternal and environmental and genetic influences in preweaning mortality.

Materials and Methods

MANAGEMENT

This work was carried out at the San El-Hagar Agricultural Company Farm, San El-Hagar area, Sharkeya Province, Egypt, from January 1993 to June 1994. The data set included three commercial rabbit breeds {Bauscat (Bau), New Zealand White (NZW) & Californian (Cal)}. The does and bucks were housed separately in individual galvanized wire batteries. Batteries for does were provided with external nest boxes for delivery and nursing young. Bucks were allocated to the does at random at each mating period and inbreeding was minimized by avoiding closely related matings (full-sib, half-sib and parent-offspring matings). The buck/doe ratio was low (1:6) and this allowed all matings contemporaneously. The animals were reared under similar environmental conditions. They were fed *ad libitum* on a commercial pelleted rabbit ration. The composition of that ration was 18% crude protein, 3% ether extract, 14% crude fibre, 2% mineral mixture (1% Ca, 0.7% P and 0.3 Na) and 63.0 % soluble carbohydrate. The digestible energy was 2600 kcal per kg ration. Constant fresh water was provided from automatic drinkers with nipples.

MEASUREMENTS AND STATISTICAL METHODS

The records analysed used comprised 4354 parturitions. Data were collected at birth, 21 and 30 days. The weaning age was 30 days. Traits analysed were stillbirths (Sb%), mortality to 21 days (M21%) and total mortality (TM%).

The data were analysed by using Mixed Model least-squares and Maximum likelihood Mean of HARVEY (1990). Model type 4 of Harvey, (1990) was adopted for each breed. The data were statistically analysed according to the following models: $Y_{ijklmn} = \mu + S_i + D_{ij} + A_k + P_l + Z_m + e_{ijklmn}$, Where: Y_{ijklmn} = Sb, M21 or TM%; S_i = random effect associated with the *ith* sires of does; D_{ij} = random effect associated with the *jth* doe within sire; A_k = fixed effect due to the *kth* season of kindling, l= 1,..4 (Winter, Spring, Summer and Autumn); P_l = effect due to *lth* parity l=1,..≥7; Z_m = fixed effect due to *mth* litter size at birth and e_{ijklmn} = random residual component associated with the *ijklmnth* observation, assumed to be normally and independently distributed with mean zero and variance $\sigma^2 e$. The variance components {Sire ($\sigma^2 s$), doe within sire ($\sigma^2 d{:}s$) and residual ($\sigma^2 e$)} were obtained by equating the mean squares for random effects to their expected values (HENDERSON, 1953). The paternal half-sib heritability ($h^2 s$) was calculated as.
$h^2 s = 4\sigma^2 s / (\sigma^2 s + \sigma^2 d{:}s + \sigma^2 e)$.
The repeatability (t) was calculated as.
$t = (\sigma^2 s + \sigma^2 d{:}s) / (\sigma^2 s + \sigma^2 d{:}s + \sigma^2 e)$.

The data reanalysed by using a mixed model, model type 5 of Harvey, (1990), was adopted for all breeds. The statistical model included the sire of doe within breeds and doe within sire within breeds as random effect and breeds, season of kindling and parity of doe as fixed effects. Percentage of mortality were subjected to arc-sin transformation.

Results

NON-GENETIC EFFECTS

Least squares means and the analyses of variance of Sb, M21 and TM% are presented in Tables 1, 2, 3 and 4. Differences between breeds were not significant in all traits studied (Table 1). Season of kindling significantly ($P<0.05$ or 0.01) affected Sb, M21 and TM% in Bau and NZW, except Sb in Bau breeds was not significant (Table 2, and 3). However, mortality traits in Cal breed were not significantly affected by season of kindling (Table 4). Sb, M21 and TM% were lowest during Spring in all breeds studied. Parity of doe significantly ($P<0.01$ or 0.001) affected all traits studied. The first parity recorded the highest Sb, M21 and TM% in all breeds. All mortality traits were decreased as parity increased. Litter size at birth significantly ($P<0.001$) affected all mortality traits. Sb% were decreased with the increase of litter size at birth. The antagonism trends were observed for M21 and TM% with large litter size at birth (=> 9 litters in Bau and NZW and =>10 in Cal breed).

GENETIC EFFECTS

Variance components {Sire ($\sigma^2 s$), doe within sire ($\sigma^2 d{:}s$) and residual ($\sigma^2 e$)}, proportion of variance, heritability ($h^2 s$) and repeatability (t) are presented in Tables 4 and 5. The proportion of $\sigma^2 s$ and $\sigma^2 d{:}s$ variance for mortality traits were low and close to zero (0-11%). The proportion of $\sigma^2 e$ was high for Sb, M21 and TM% in all breeds. The heritability obtained for each of Sb, M21 and TM% were low (0.0-0.17) and not significantly different from zero. The repeatability (t) values for mortality traits were also low in all breeds.

Discussion

The results show a pronounced effect for genetic and non-genetic influences on mortality traits.

The total mortality percentage (TM%) was very similar for Bau, NZW and Cal purebreds (24, 22 and 21%, respectively) and the differences were not significant. Overall mean percentage of mortality agree with the findings of PARTRIDGE *et al*. (1981).

The differences in Sb, M21 and TM% among seasons may be attributed to the variation in climatic conditions, especially temperature and relative humidity. The lower litter mortality were recorded during Spring in all breeds, a results agrees with the findings that reported by EMARA (1982). The highest percentage of Sb was found in the first parity for all the breeds may be due to pelvic of the doe which may not well develop. Also, the highest percentage of M21 and TM% were found in the first parity may be due to maternal ability such as deficient in pups care from the young does. However, mortality percentage decreased as parity increased. Similar results were reported by GUALTERIO *et al.*, (1988) and AFIFI *et al.*, (1992). Large litters (=< 9), mortality was much higher, corresponding to a marked rise in the percentage of young born dead. Because the suckling period in the rabbit is very short (2.7 to 4.5 min/day, ZARROW *et al.* 1965), it might be expected that deaths due to chilling and starvation would be more prevalent in large litters, where competition for teats is greater. Teat number in the doe ranges from 8 to 10 (MAY and SIMPSAN, 1975). However, the teat number was of no evidence from the results that such deaths were less likely in litters of eight or less size. Theoretically each young would have access to at least one teat during the suckling period and insufficient doe to care large litter (PARTRIDGE, 1981). Litter size at birth was a major maternal factor affecting Sb, M21 and TM% traits. In small litter size (<=3) and large litters (>=9) mortality traits were much higher. Mortality rate was highest in very small litter size at birth (BROECK and LAMPO, 1975, and EL-DARAWANY In Press). Therefore, evaluating doe for natal and postnatal litter mortality, adjustments might be made by other performance traits such as litter size at birth.

The σ^2s and σ^2d:s variance for Sb, M21 and TM% were low and close to zero. These results indicated a large σ^2e influence on these traits. The low σ^2s of mortality traits indicates that the relative importance of additive genetic factors is low and most improvement of these traits of commercial breeds could be realized by improvement of environment and management of the doe and litter during gestation periods and after birth, because the period from birth to weaning is most sensitive to environment and management changes. The h^2 obtained for Sb, M21 and TM% traits in all breeds were low and not significantly different from zero. The h^2 estimate for mortality traits obtained was almost at the same level as reported by KHALIL et al., (1988). The h^2 estimates obtained in the present study suggested that selection would not be effective in the process of improving mortality traits. The low repeatability values in the present study for Sb, M21 and TM% traits were noted by LUKEFAHR *et al.* (1984), AFIFI *et al.* (1992) and KHALIL (1993). These results indicated that variation in environmental conditions was high, thus increasing accordingly temporary differences (PIRCHNER 1983).

Conclusions

In conclusion, the largest litter raised by any doe was >= 9. Some postnatal losses amongst litters larger than this size at birth might have been avoided by following the commercial practice of fostering the excess, but the bulk of death from chilling and/or starvation would have remained, especially in winter. These losses may be prevented and controlled by nursing does. Low heritability for all mortality traits indicates that genetic improvement by selection would be difficult, while improvement the environmental and managemental factors (climate, feed, hygiene ect.) might be improve the performance of the young.

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Table 1. Least squares means and F-values of stillbirths (Sb), mortality to 21 days (M21) and total mortality % (TM) in all breeds studied.

Classification	No.	d.f	Sb Mean	Sb F.	M21 Mean	M21 F.	TM Mean	TM F.
Overall	4354		11.23		20.12		22.61	
Sire:breed		99		1.58***		1.48**		1.39**
Doe:sire:brred		1005		1.29***		1.30***		1.29***
Breeds		2		1.13ns		2.45ns		2.09ns
Bau	2252		11.56		21.63		24.09	
NZW	1577		10.06		19.18		22.06	
Cal	525		12.06		19.56		21.67	
Season of kindling		3		5.47***		12.07***		10.31***
Winter	1209		12.03		21.37		23.68	
Spring	1198		8.14		15.23		18.03	
Summer	1015		12.47		21.89		24.45	
Autumn	932		12.27		21.99		24.28	
Parity		6		14.49***		19.90***		21.96***
1	956		17.39		29.79		33.46	
2	777		16.11		24.06		26.36	
3	640		12.35		21.65		24.49	
4	479		13.22		21.01		23.24	
5	386		10.99		19.09		21.44	
6	310		5.18		13.02		15.56	
≥7	806		3.36		11.41		13.72	
Remainder MS		3228	576.26		646.34		666.82	

Key to abbreviations are given in Materials and Methods.
(*** P<0.001, ** P<0.01, * P<0.05 or ns not significant).

Table 2. Least squares means and F-values of stillbirths (Sb), mortality to 21 days and total mortality % in Bauscat breed.

Classification	No.	d.f	Sb Mean	Sb F.	M21 Mean	M21 F.	TM Mean	TM F.
Overall	2252		14.16		23.09		25.26	
Sire		48		1.22ns		1.24ns		1.19ns
Doe:sire		543		1.25***		1.29***		1.25***
Season of kindling		3		2.46ns		6.59***		5.19**
Winter	608		16.26		25.15		26.87	
Spring	610		11.99		18.11		20.72	
Summer	535		13.64		24.46		26.88	
Autumn	499		14.73		24.64		26.58	
Parity		6		3.38**		6.45***		6.49***
1	465		17.74		30.76		33.98	
2	395		17.45		25.40		27.25	
3	331		14.69		24.42		26.28	
4	245		14.50		22.84		24.87	
5	213		15.80		24.76		26.05	
6	168		10.35		17.90		20.13	
>7	435		8.56		15.54		18.27	
Litter size at birth		7		59.04***		26.75***		21.67***
≤3	227		43.12		44.74		44.90	
4	130		21.03		25.36		27.01	
5	169		14.75		20.11		21.16	
6	271		9.09		16.75		18.59	
7	339		8.33		17.21		19.95	
8	433		5.46		15.46		18.59	
9	317		6.29		21.14		24.45	
≥10	366		5.18		23.96		27.45	
Remainder MS		1644	486.31		595.84		624.17	

Key to abbreviations are given in Materials and Methods.
(*** P<0.001, ** P<0.01, * P<0.05 or ns not significant).

Table 3. Least squares means and F-values of stillbirths (Sb), mortality to 21 days and total mortality % in New Zealand White breed.

Classification	No.	d.f	Sb Mean	Sb F.	M21 Mean	M21 F.	TM Mean	TM F.
Overall	1577		11.33		19.43		22.02	
Sire		38		1.58*		1.63*		1.54*
Doe:sire		350		1.56***		1.23**		1.27**
Season of kindling		3		3.46*		5.41***		4.47***
Winter	469		12.61		20.97		23.42	
Spring	452		7.88		14.41		17.35	
Summer	346		11.78		20.88		23.45	
Autumn	310		13.07		21.68		23.85	
Parity		6		8.48***		9.62***		11.24***
1	368		19.18		29.87		33.96	
2	292		16.53		24.75		27.13	
3	233		12.03		19.65		23.24	
4	179		13.05		20.89		23.00	
5	129		8.99		17.07		18.85	
6	107		4.66		11.54		14.32	
≥7	269		4.90		12.26		13.60	
Litter size at birth		7		22.47***		9.62***		8.24***
≤3	117		36.56		36.84		37.47	
4	75		11.59		16.94		18.35	
5	152		6.98		11.54		13.17	
6	229		9.53		17.28		19.83	
7	283		8.05		14.58		17.60	
8	283		6.45		16.57		19.72	
9	199		6.89		18.85		23.56	
≥10	239		4.83		22.85		26.42	
Remainder MS		1172	443.80		580.52		608.55	

Key to abbreviations are given in Materials and Methods.
(*** P<0.001, ** P<0.01, * P<0.05 or ns not significant).

Table 4. Least squares means and F-values of stillbirths (Sb), mortality to 21 days and total mortality % in Californian breed.

Classification	No.	d.f	Sb Mean	Sb F.	M21 Mean	M21 F.	TM Mean	TM F.
Overall	525		13.30		19.42		21.47	
Sire		13		1.45ns		0.90ns		0.79ns
Doe:sire		112		1.21ns		1.30*		1.26*
Season of kindling		3		1.73ns		1.70ns		1.81ns
Winter	132		17.51		22.60		24.61	
Spring	136		9.68		15.00		16.65	
Summer	134		14.06		20.72		22.95	
Autumn	123		11.95		19.36		21.65	
Parity		6		3.39**		4.89***		5.21***
1	123		24.07		34.54		37.72	
2	90		15.41		20.88		23.42	
3	76		11.59		20.01		22.71	
4	55		15.97		18.54		20.71	
5	44		10.31		16.09		16.43	
6	35		9.94		14.81		15.97	
≥7	102		5.80		11.08		13.31	
Litter size at birth		7		10.89***		7.37***		6.42***
≤3	56		41.50		44.77		44.94	
4	19		17.39		16.58		20.45	
5	47		13.56		15.98		16.17	
6	72		9.66		16.88		19.27	
7	84		10.78		16.64		19.16	
8	95		5.10		13.46		14.66	
9	69		2.66		11.08		13.54	
≥10	83		5.74		19.99		23.54	
Remainder MS		383	569.88		626.40		656.17	

Key to abbreviations are given in Materials and Methods.
(*** P<0.001, ** P<0.01, * P<0.05 or ns not significant).

Table 5. Variance components and proportion of variance (between parentheses) for stillbirths, mortality to 21 days and total mortality in Bauscat, New Zealand White and Californian breeds.

Breeds#	Variance components of traits								
	Sb%			M21%			TM%		
	$\sigma^2 s$	$\sigma^2 d{:}s$	$\sigma^2 e$	$\sigma^2 s$	$\sigma^2 d{:}s$	$\sigma^2 e$	$\sigma^2 s$	$\sigma^2 d{:}s$	$\sigma^2 e$
Bau	6.87	31.39	488.32	9.46	44.59	595.84	7.72	40.51	624.17
	(1.31)	(5.98)	(92.71)	(1.46)	(6.86)	(91.68)	(1.15)	(6.02)	(92.83)
NZW	22.00	60.19	443.80	23.21	33.17	580.52	21.76	39.95	608.55
	(4.18)	(11.44)	(84.37)	(3.64)	(5.21)	(91.15)	(3.25)	(5.96)	(90.79)
Cal	14.95	29.80	569.88	0	47.11	626.40	0	41.88	656.17
	(2.43)	(4.85)	(92.72)	(0)	(6.99)	(93.01)	(0)	(6.00)	(94.00)

Key to abbreviations are given in Materials and Methods.
0 Negative estimate of variance components set to zero.

Table 6. Estimates of heritability and repeatability of stillbirths (Sb%), mortality to 21 days (M21%) and total mortality (TM%) in Bauscat (Bau), New Zealand White (NZW) and Californian (Cal) breeds.

Traits %	Heritability±SE (h^2s)			Repeatability±SE (T)		
	Bau	NZW	Cal	Bau	NZW	Cal
Sb	0.052±0.038	0.167±0.064	0.097±0.095	0.073±0.019	0.156±0.026	0.073±0.036
M21	0.058±0.039	0.146±0.061	0	0.083±0.019	0.089±0.023	0.075±0.037
TM	0.046±0.037	0.130±0.058	0	0.072±0.019	0.092±0.023	0.060±0.030

Key to abbreviations are given in Materials and Methods.
0 Negative estimate of sire component of variance set to zero.