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Effects on maternal performance and litter preweaning traits in doe rabbits

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Introduction

The components of doe productivity generally include the number of bunnies born per litter and mortality rate to weaning. However, in view of the economic importance of doe productivity, it is important to identify its most important components and to estimate their genetic and phenotypic parameters. In this respect, estimates of repeatability of doe reproductive traits must be known for effective early selection and the planning of culling programs. Repeatability estimates for litter traits of the doe are generally low or moderate in magnitude (Rouvier et al. 1973; Garcia et al. 1982; Lukefahr et al. 1983; Lahiri 1984; Lukefahr et al. 1984).

The mating buck had little or no effect on litter traits at birth and / or at weaning (Rouvier et al. 1973; Kadry and Afifi 1983; Khalil and Mansour 1987). On the other hand, the doe contributes strongly to the performance of her litter at birth and at weaning (Rouvier et al. 1973; Garcia et al. 1980; Randi and Scossiroli 1980; Garcia et al. 1982; Lukefahr et al. 1983; Lukefahr et al. 1984). These reviewed results suggest that doe litter traits are a female trait and should improved primarily through the choice of the doe based on her own or her dam's performance.

The objectives of the present study were (1) to quantify differences in litter traits due to mating buck and doe effects, (2) to estimate repeatabilities for doe litter traits, and (3) to detect residual correlations among different doe litter traits.

Materials and methods

Data on 817 purebred litters were collected from the Rabbitry of Dokki Experimental Station, Animal Production Research Institute, Ministry of Agriculture, Cairo over eight consecutive production years (from September 1971 to May 1979). Purebred litters of two exotic breeds (White Flander and Bauscat) and two native breeds (Baladi Red and Giza White) were used. At the beginning of the breeding season (September–October), the available breeding females within each breed were randomly assigned to mating bucks. Full-sib, halb-sib, sire-daughter and son-dam matings were avoided. Each doe was mated to only one buck during her productive life. She was transferred to the buck's hutch to be mated and returned to its own hutch after being mated. Hand mating was exercised by restraining the doe to assure copulation. Does were weighed at each mating and palpated 10 days thereafter to determine pregnancy. Does that failed to conceive were returned to the same buck every alternate day thereafter until a conception was observed. The litter of the young rabbits was examined and recorded within 24 hours of birth. Does were mated 7 days after each parturition. Weaning was practised at 35 days of age.

Rabbits were always fed ad libitum and feed was introduced twice a day. In the morning a dry mash of about 16 % total protein and 60 % starch equivalent was given throughout the

year. At noon, barseem *(Trifolium alexandrinum)* was provided when seasonally available but during summer months barseem was substituted with barseem hay and / or green corn plants (locally called Drawa). Fresh clean water was available to rabbits at all times.

Litter traits included in this study were gestation length (GL), litter size at birth (LSB) and at weaning (LSW), preweaning litter mortality (PM) and litter sex ratio (SRW) at weaning (percent of males relative to all males and females). Data were available on 491 does mated to 122 bucks. HARVEY's (1977) Mixed Model Computer program was used for analysing the data. The fixed effects included in the model were breed, year of kindling, parity and month of kindling. Bucks within breed and does within bucks within breed were considered to be random effects in the model. The mean squares for bucks within breed was used to test for significance of breed effects. The mean squares for does nested within bucks and breed were used to test for significance of bucks within breed. Test of significance of all other effects was made by using the remainder mean square. Percentages of preweaning litter mortality and sex ratio at weaning were subjected to arc-sin transformation before being analysed in order to make variances homogeneous.

Estimates of variance components were calculated using Method 3 of HENDERSON (1953). By equating the mean squares of each random effect to its expectation, estimates of the variance components, i. e. mating buck within breed ($\sigma^2 B$), doe within buck within breed ($\sigma^2 D$) and remainder ($\sigma^2 E$) were obtained. For the estimation of repeatability, data were adjusted for known and quantifiable temporary environmental effects but not for genotypic or permanent environmental effects. Therefore, repeatability estimates were computed from the ratio of doe variance component ($\sigma^2 D$) to the sum of $\sigma^2 B$, $\sigma^2 D$ and $\sigma^2 E$. Approximate standard errors for the repeatability estimates were computed with procedures described by SWIGER et al. (1964). Residual correlations among different litter traits studied (after adjustment for all effects included in the model) were obtained from least squares analysis of variance (HARVEY 1977).

Results and discussion

Breed and non-genetic effects

White Flander were characterized by shorter GL (31.1 days) and larger LSB 7.12 young) than other breeds studied, but had the largest litter losses (47.0 %) together with the smallest LSW (4.35 young) and SRW (38.7 %). Poor maternal ability of White Flander during the suckling period, i. e. failure to provide adequate milk, was chiefly responsible for the lowered proportion of bunnies weaned to that breed compared with Baladi Red rabbits (KHALIL et al. 1988). Breed effects on GL, PM and SRW were not significant while they were significant (P<0.001) for LSB and LSW. Evidence is available in the Egyptian studies on breed differences for LSB and/or LSW (e. g. AFIFI et al. 1976; AFIFI et al. 1982).

Litter traits studied varied with respect to the significance of the effect of year of kindling. It was highly significant (P<0.001) for GL, LSB and PM and non-significant for LSW and SRW. Similar results were obtained in the Egyptian studies (AFIFI et al. 1976; AFIFI et al. 1982; KHALIL et al. 1987; KHALIL et al. 1988) for the same or different breeds of rabbits.

The only trait exhibiting a clear trend over the parities was LSB, which increased in a linear fashion consistently. These findings can be expected because does in their first parity have just reached sexual maturity and consequently their ovulation rate and their efficiency in providing their young with nourishment and intra-uterine environment during the prenatal development are at lowest level (AFIFI et al. 1982; KHALIL et al. 1987). However, the pattern of change in LSB due to parity effects may be resultant of changes in physiological efficiency of the doe which occurs with advance of parity especially those related to ovulation rates, implantation sites, embryonic mortality rates, viability of foetus and due to differences in the intra-uterine environment during gestation period (AFIFI et al. 1982; KHALIL et al. 1988).

Month-of-kindling differences in litter traits existed, usually with an advantage for February-born litters. This could be explained due to the availability of abundant good quality green fodder during this month.

Random effects

Variance component estimates are presented in Table 1. The mating buck affected and contributed to the variance (P<0.05 or P<0.001) of GL and PM (Table 1). On the other hand, the mating buck had little or no effect on LSB, LSW and SRW. However, the mating buck affects doe litter performance through its direct genetic effects on growth and livability of young during pre-natal and post-natal periods. Different trends for the service-sire effects on doe litter performance have been cited in the literature (Khalil and Mansour 1987). Rouvier et al. (1973) stated that the service sire had little or no effect on total number born and litter size and mortality rate at 21 and 56 days of age. Similarly, Kadry and Afifi (1983) found a nonsignificant mating-buck effect on litter size at birth in Bauscat rabbits.

Differences in litter traits due to doe effects were highly significant (P < 0.001) with the exception of PM (Table 1). Similarly, some investigators (Garcia et al. 1980; Randi and Scossiroli 1980; Garcia et al. 1982, Lukefahr et al. 1983) reported that the doe contributes siginificantly to the phenotypic value of her litter traits not because of her gene transmission but due to her maternal environmental effects on them. However, highly significant (P < 0.001) doe effect on most of litter traits studied (Table 1) indicate that litter traits must be analysed as traits of the doe producing the litter. This will support the evidence that size of litter is primarily dependent on the doe and not on the service buck.

Repeatability

Estimates of repeatability for litter traits studied are given in Table 1. These results indicate that doe litter traits were of low repeatability. Also, most of the estimates high standard errors. However, repeatability estimates for doe litter traits in the present study agree generally with the corresponding estimates reported in the literature (Rouvier et al. 1973; Garcia et al. 1982; Lukefahr et al. 1983; Lahiri 1984; Lukefahr et al. 1984; Khalil and Mansour 1987). Because of low repeatability more litters are to be considered before selecting a doe for such traits. Therefore, culling of does for litter traits based on a single production record would not be efficient from a genetic standpoint and consequently assessment of several parities are required before selecting does for litter traits (Khalil and Mansour 1987).

Residual correlations

Residual correlations among litter traits studied are provided in Table 2. GL was poorly related to litter traits studied (all correlations < 0.058 in absolute value). Likewise weak

Table 1. **Estimates (σ^2) and proportions (V%) of random components of variance and repeatability estimates (t) for litter traits studied**

Traits	Buck/breed		Doe/buck/breed		Remainder		t ± S.E.
	σ^2 B	V%	σ^2 D	V%	σ^2 E	V%	
GL	0.12***	12.5	0.01***	1.0	0.83	86.5	0.010 ± 0.073
LSB	0.14	3.2	0.33***	7.6	3.85	89.1	0.076 ± 0.074
PM	30.10*	2.6	a	0.0	1113.52	97.4	a
LSW	0.17	4.0	0.47***	11.1	3.61	84.9	0.111 ± 0.091
SRW	a	0.0	6.05***	1.6	379.10	98.4	0.015 ± 0.092

a Negative variance component estimates set to zero.
* = P < 0.05 and *** = P < 0.001.

Table 2. **Residual correlations⁺ among litter traits studied**

Traits	LSB	LSW	PM	SRW
GL	−0.023	−0.003	0.035	−0.058
LSB		0.621**	−0.105	0.105
LSW			−0.598**	0.120
PM				−0.070

⁺ Correlations greater than 0.25 in absolute value are different from zero at P < 0.01.
** = P < 0.01

correlations between LSB, LSW and SRW were obtained. As number of bunnies born and weaned in the litter increased, PM tended to increase (Table 2). This tend of correlations between LSB, LSW and PM is in agreement with findings of LUKEFAHR (1982). On the other hand, LSB and LSW were highly positively correlated (P < 0.01). This is due to their part-whole relationship. The estimate of 0.621 obtained between LSB and LSW (Table 2) are within the range of 0.45 to 0.68 obtained by other investigators (AFIFI et al. 1980; LAHIRI and MAHAJAN 1982) working on different breeds of rabbits.

Summary

An analysis of maternal performance and litter preweaning traits was carried out on 817 purebred Bauscat, Giza White, White Flander and Baladi Red litter records including 491 does mated to 122 bucks. Traits investigated involved gestation length (GL), litter size at birth (LSB) and at weaning (LSW), preweaning litter mortality (PM) and litter sex ratio at weaning (SRW). Breed effects on GL, PM and SRW were not significant, while they were significant for LSB and LSW. Year of kindling affected significantly GL, LSB and PM. No pattern of parity and month of kindling effects on most of litter traits were observed. The mating buck contributed significantly to the variance of GL and PM while a little or no effects on LSB, LSW and SRW were detected. Differences due to doe effects in maternal performance and litter preweaning traits were highly significant with the exception of PM. Estimates of repeatability for doe litter traits studied were low in magnitude. GL was little related to other litter traits studied while LSB and LSW were highly positively correlated.

Zusammenfassung

Wirkungen auf Mutterleistung und Wurfeigenschaften bei Kaninchen

Eine Analyse mütterlicher Leistung und von Wurfeigenschaften wurde an 817 reinrassigen aus Bauscat, Giga Weiß, weiße Flandern und Rote Baladi Kaninchen durchgeführt, die von 491 Häsinnen und 122 Böcken stammten. Die untersuchten Merkmale waren Trächtigkeitsdauer (GL), Geburtswurfgröße (LSB). Wurfgröße (LSW), Wurfverluste (PN) und Geschlechtsverhältnis beim Absetzen (SRW). Die Rasseneinflüsse auf GL, PM und SRW waren nicht signifikant, wohl aber für LSB und LSW. Jahr des Wurfes hat GL, LSP und PM signifikant beeinflußt. Kein Muster von Wurffolge und Wurfmonat wurde bei den meisten Wurfmerkmalen beobachtet. Der Paarungspartner hat signifikant zur Varianz von GL und PM beigetragen, aber nicht oder nur sehr wenig bei LSB, LSW und SRW. Unterschiede bezüglich Häsinnen in mütterlicher Leistung und Wurfmerkmalen waren hoch signifikant, mit Ausnahme von TM. Wiederholbarkeitsschätzungen für Häsinnen und Wurfmerkmale waren gering. GL war wenig korreliert mit anderen Wurfmerkmalen, während LSB und LSW stärker zusammenhängen.

Resumen

Efectos sobre la produccion materna y caracteristicas de la camada en conejos

Un análisis de la producción materna y de características de la camada fue realizada en 817 conejos de razas puras Bauscat: Giaza Blanco, Blanco Flándes y Rojo Baladi, camadas provenientes de 491 hembras y de 122 machos. Las características que se analizaron fueron: Largo de gestación (GL); tamaño de la camada al nacimiento (LSB), tamaño de camada (LSW), péridas en la camada (PM) y relación entre sexos al destete (SRW). El efecto de raza no fue significativo para GL, PM y SRW; y si lo fue en cambio para LSB y LSW. Año de parto afectó significativamente a GL, LSB y PM. Ningún padrón se observó para número del parto y mes de parto en las características de la camada. El tipo de cruzamiento contribuye significativamente a las varianzas para GL y PM, pero no contribuye o solo muy poco para LSB, LSW y

SRW. Diferencia relacionadas a la producción de las madres y características de la camada fueron muy significativas, a excepción de PM. La estimación de la repetibilidad en las conejas madres y en sus características de la camada fueron pequeñas. GL esta levemente correlacionada con otras caracteristicas de lạ camada, mientras que LSB y LSW presentan correlaciones altas y positivas.

Acknowledgement

References

AFIFI, E. A.; GALAL, E. S. E; EL-TAWIL, E. A.; EL-KHISHIN, S. S., 1976: Litter size at birth and at weaning in three breeds of rabbits and their crosses. Egypt. J. Anim. Prod. 16: 109–119.

AFIFI, E. A.; GALAL, E. S. E; EL-OKSH, H. A.; KADRY, A. E. H., 1980: Inter-relationships among doe's weight, litter size, litter weight and body weight at different ages in rabbits. Egypt. J. Anim. Prod. 20: 127–136.

AFIFI, E. A.; GALAL, E. S. E.; KADRY, A. E. H., 1982: The effect of breed and some environmental factors on litter traits in rabbits. 7th Internat. Congr. Stat., Computer Sci., Soc. Demographic Res., 27 March – 1 April 1982, Cairo, Ain Shams University, Cairo, Egypt, pp. 311–324.

GARCIA, F.; BLASCO, A.; BASELGA, M.; SALVADOR, A.; 1980: Genetic analysis of some reproductive traits in meat rabbits. Proc. 2nd World Rabbit Congr. 14–18 April 1980, Barcelona, Spain, pp. 202–212.

GARCIA, F.; BASELGA, M.; BLASCO, A.; DELTORO, J., 1982: Genetic analysis of some productive traits in meat rabbits. I-Numeric traits. Proc. 2nd World Congr. Genetics Appl. Livest. Prod., 4–8 October 1982, Madrid, Spain, pp. 557–562.

HARVEY, W. R., 1977: User's Guide for LSML-76, Mixed Model Least-Squares and Maximum Likelihood Computer Program, Mimeograph, Ohio State University, USA.

HENDERSON, C. R., 1953: Estimation of variance and covariance components. Biometrics 9: 226–252.

KADRY, A. E. H.; AFIFI, E. A., 1983: Effect of the buck on number of services per conception, service period and litter size at birth in Bauscat rabbits. Anim. Reprod. Sci. 5: 219–222.

KHALIL, M. H.; MANSOUR, H., 1987: Factors affecting reproductive performance of female rabbits. J. Applied Rabbit Research 10 (3): 140–145.

KHALIL, M. H.; OWEN, J. B.; AFIFI, E. A., 1987: A genetic analysis of litter traits in Bauscat and Giza White rabbits. Anim. Prod., 45: 123-134.

KHALIL, M. H.; AFIFI, E. A.; EMARA, M. E.; OWEN, J. B., 1988: Genetic and phenotypic aspects of doe productivity in four breeds of rabbits. J. Agric. Sci., Cambridge 110: 191–197.

LAHIRI, S. S., 1984: Possibility of early selection in New Zealand White rabbits. Livestock Adviser 10 (2): 11–12

LAHIRI, S. S.; MAHAJAN, J. M., 1982: Note on the inheritance of age at first breeding, litter size and weight in rabbits. Indian J. Anim. Sci. 52 (11): 1148–1150.

LUKEFAHR, S., 1982: Evaluation of rabbit breeds and crosses for overall commercial productivity. Ph. D. Thesis, Oregon State University, Corvallis, USA.

LUKEFAHR, S.; HOHENBOKEN, W. D.; CHEEKE, P. R.; PATTON, N. M., 1983: Doe reproduction and preweaning litter performance of straightbred and crossbred rabbits. J. Anim. Sci. 57 (5): 1090–1099.

–, 1984: Genetic effects on maternal performance and litter pre-weaning and post-weaning traits in rabbits. Anim. Prod. 38: 293–300.

RANDI, E.; SCOSSIROLI, R. E., 1980: Genetic analysis of Production traits in Italian New Zealand White and California pure-breed populations. 2nd World Rabbit Congr. 14–18 April 1980, Barcelona, Spain, pp. 191–201.

ROUVIER, R.; POUJARDIEU, B., VRILLON, J. L., 1973: Statistical analysis of the breeding performance of female rabbits: Environmental factors, correlations and repeatabilities, Annales de Genetique et Selection Animale 5 (1): 83–107.

SWIGER, L. A.; HARVEY, W. R.; EVERSON, D. O.; GREGORY, K. E., 1964: The variance of intraclass correlation involving groups with one observation. Biometrics 20: 818–826.

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