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GENETIC ANALYSIS FOR SOME REPRODUCTIVE TRAITS IN FEMALE RABBITS

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Abstract

Records on 873 litters of Bauscat and Giza White rabbits were collected for eight consecutive years beginning in October, 1975. Heritability for age of doe at first kindling (AFK) and heritabilities and repeatabilities for number of services per conception (NSC) and gestation length (GL) were estimated. Fifty two sires and 211 daughters (paternal half-sisters) were used for the analysis of these traits. Year of production had highly significant ($P<0.01$ or $P<0.001$) influence on reproductive traits studied with the exception of AFK in Bauscat and GL in Giza White rabbits. Does that had their first service in autumn months required ($P<0.01$ or $P<0.001$) less NSC and AFK than those that had their first service in winter months. NSC and GL increased with advance of parity. Sire of doe was found to be an important source of variation for AFK, while having little or no effect on NSC and GL. Heritability estimates in Bauscat and Giza White rabbits, respectively, were 0.62 and 0.91 for AFK, 0.0 and 0.17 for NSC and 0.05 and 0.0 for GL. Estimates of repeatability for NSC and GL were low in the two breeds studied.

Introduction

Age of doe at first kindling and number of services per conception are important traits in determining the breeding efficiency of commercial herds of rabbits. Also, pregnancy is the most important stage in rabbit meat production. In spite of the economic importance of these reproductive traits for the rabbit industry, few studies have been published to evaluate genetically and phenotypically such reproductive traits (Lahiri and Mahajan, 1982; Afifi and Kadry 1985; Khalil and Mansour, 1987). In this respect, Lahiri and Mahajan (1982) reported a low heritability estimate of 0.187 for age of doe at first breeding in New Zealand White rabbits. However, estimates of heritability and repeatability for number of services per conception and gestation length in rabbits are not available.

The objectives of the present study were (1) to investigate the effects of non-genetic factors on age of doe at first kindling, number of services per conception and gestation length, (2) to quantify variation in such traits due to sire of doe and doe within sire, and (3) to estimate the heritabilities and repeatabilities for such doe reproductive traits.

Materials and Methods

Data on 873 litters were collected for 8 consecutive production years starting from October, 1975, to September, 1983. Rabbits of a foreign breed (Bauscat) and native breed (Giza White) were used. Young does were first mated at the age of 8 months. At the beginning of each breeding season (October), does within each breed were grouped at random into groups ranging from 3 to 5 does. For each group of does a buck from the same breed was assigned at random except with the restriction that mated pairs should not have a grand-parent in common. Each doe was mated to only one buck. The doe was transferred to the buck's hutch to be mated. Hand mating was exercised by restraining the doe to assure copulation. Does were palpated 10 days thereafter to determine pregnancy. Does that failed to conceive were returned to the same mating buck to be remated, and were returned to the same buck every other day thereafter until a conception was observed. Following the kindling of the first and all subsequent litters, all does were mated 7 days after each parturition. Other details on management and feeding practices and breeding plan were reported by Khalil et al. (1987).

Each breed was analyzed sparately for three measurements of reproductive efficiency. These measurements were age of doe at first kindling (AFK), number of services per conception (NSC) and gestation length (GL). Records of the first parity (154 daughters from 41 sires) were used to estimate the variance components of AFK. Data of NSC and GL were available on 211 daughters produced by 52 sires. The Harvey's (177) mixed Model Computer Program was utilized in analyzing the data. A mixed model including the fixed effects of year and month of conception and the random effect of sire of doe was used to analyze the data of AFK. Data of NSC and GL were analyzed using the same previous effects in addition to parity as fixed effect and doe within sire as random effect. Estimates of sire (σ^2S), doe within sire (σ^2D) and remainder (σ^2e) variance components were calculated using Method 3 of Henderson (1953). Paternal half-sib heritability estimates were calculated as four times the ratio of σ^2S to the sum of the components of variance of each reproductive trait studied. The ratio $(\sigma^2S + \sigma^2D) / (\sigma^2S + \sigma^2D + \sigma^2e)$ was used as an estimator of repeatability. Standard errors for heritability and repeatability estimates were calculated using an approximation formula as described by Swiger et al. (1964).

Results and Discussion

Non-genetic effects

There was a general tendency for AFK to be low when conception took place in the early months of the year of production and to increase as month of conception advanced (Table 1). However, during the early months of the year of production, green fodder for breeding does is not available in enough quantities and is of less nutritive value. As the month of conception advances, fodder becomes more abundant and of high nutritive value and, consequently, young does become more fat and their reproductive efficiency for conception is at lowest levels. In other words, age of doe at first kindling increases with advance in month of conception. Effect of month of conception on AFK was highly significant (Table 1). AFK varied with respect to the significance of the effect of year of production (Table 1). AFK varied with respect to the significance of the effect of year of production (Table 1). In Bauscat rabbits, it was nonsignificant, while it was significant ($P<0.01$) in Giza White rabbits.

Year of production, month of conception and parity had highly significant $P<0.001$) influence on NSC (Table 1) with the exception of parity effect on NSC in Bauscat rabbits ($P<0.05$). Does that had their first service at the beginning of the breeding season (October and November) and at the end of the breeding season (March, April and May) required less NSC than those which had their first service during the winter months (December, January and February). On the contrary, Afifi and Kadry (1985) found that does that had their first service during the spring months (March, April and May) required more services than those that had their first service during autumn months (September to November) and winter months (December to February). However, Afifi and Kadry (1985) reported that the environmental conditions (e.g. ambient temperature, day light to dark ratio and availability of green fodder) during the autumn and winter months in Egypt were more suitable for reproduction in rabbits than during the spring months. Enos et al. (1979) reported that moderate ambient temperature and short days improved conception rates markedly in rabbits. NSC increased from the 1st parity to the 4th and decreased thereafter in the 5th and 6th (Table 1). Similar results were obtained by Afifi and Kadry (1985) who attributed the observed increase in NSC with advance of parity to decreased activity of the ovaries.

Year-of-production effects constituted ($P<0.001$) an important factor influencing GL in Bauscat rabbits (Table 1). No clear trend could be detected for the effect of month of conception and year of production on GL in Bauscat and Giza White rabbits (Table 1). On the contrary, Afifi and Kadry (1985) reported that does conceiving during September through February had shorter gestation lengths than those conceiving during March and April. However, Ocetkiewiez et al. (1961) and Ponce (1978) reported seasonal fluctuation in gestation length in rabbits. Generally, GL increased insignificantly with advance of parity (Table 1). Similarly, Santoro and Hernandez (1967) and El-Tawil et al. (1971) reported that length of gestation was positively associated with advance of parity.

Random Effects

The estimate of the sire, doe within sire and remaining components of variance for reproductive traits studied are shown in Table 2. These results showed that sire of doe contributed significantly ($P<0.05$) to the total variance of AFK (proportion of variation = 15.6 and 22.9 in Bauscat and Giza White rabbits, respectively), while little or no effect of sire on NSC and GL (proportion of variation = 1.2 and 4.1) was observed. It therefore cautions against neglect of the mating buck and concentrating only on the sire of doe when undertaking studies on NSC in rabbits. In this respect, Khalil and Mansour (1987) reported a highly significant effect of mating buck on NSC, indicating the importance of evaluating buck semen quality before the mating season.

Differences in NSC and GL due to doe effects (Table 2) were nonsignificant with the exception of GL in Bauscat rabbits (V% = 14.7), suggesting the existence of a negative covariance between adjacent litters (Khalil and Mansour, 1987).

Heritabilities and repeatabilities

Heritabilities and repeatabilities of doe reproductive traits studied are presented in Table 2. Estimates of heritability and repeatability for doe reproductive traits studied in the Bauscat are generally lower than the corresponding estimates in Giza White rabbits. This may be due to reduction in genetic variation of reproductive traits through previous selection in the Bauscat breed (French) in its own country, in comparison to little intensive selection for the Giza White (native) breed in Egypt.

The magnitude of heritability for AFK (0.62 and 0.91 in Bauscat and Giza White rabbits, respectively) indicated that improvement in AFK can be made through selection. However, the heritability estimates for AFK in both breeds are much higher (with higher standard errors) than the corresponding estimates of 0.187 obtained by Lahiri and Mahajan (1982) for New Zealand White rabbits.

Estimates of heritability for NSC and GL were low in magnitude (Table 2). The observed trend of low and almost similar estimates of heritability and repeatability of NSC and GL (Table 2) indicated that there is little permanent environmental variance influencing the traits and that more litters should be considered before selecting a doe for these traits. Similarly, the low repeatability estimates for these traits indicated again that assessment of several records is required before selecting does for these traits.

Negative heritability estimates obtained for traits studied (NSC in Bauscat and GL in Giza White) are the result of negative variance components of sires in the analysis of variance (Table 2). Negative variance components are regarded as an indication of negligible contribution to variation of the traits (S) under study. Sampling effect and non-randomness in the distribution of daughters within sire groups could be added as other causes in this respect.

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TABLE 1

Least squares means ($\bar{X}$), standard errors (S.E.) and tests of significance of factors affecting prekindling reproductive traits in Bauscat and Giza White rabbits.

Independent Variable	Bauscat AFK (month) N	Bauscat AFK (month) $\bar{X}$ ± S.E.	Bauscat NSC N	Bauscat NSC $\bar{X}$ ± S.E.	Bauscat GL (day) $\bar{X}$ ± S.E.	Giza White AFK (month) N	Giza White AFK (month) $\bar{X}$ ± S.E.	Giza White NSC N	Giza White NSC $\bar{X}$ ± S.E.	Giza White GL (day) $\bar{X}$ ± S.E.
Year of Production		NS		***	***		**		***	NS
1975-1976	13	11.5 ± 0.4	80	2.8 ± 0.2	31.5 ± 0.1	6	13.0 ± 0.6	66	2.8 ± 0.3	31.4 ± 0.2
1976-1977	24	10.9 ± 0.4	104	2.2 ± 0.2	31.2 ± 0.1	25	10.5 ± 0.3	70	2.1 ± 0.3	31.0 ± 0.2
1977-1978			72	3.8 ± 0.3	31.1 ± 0.2			59	3.9 ± 0.3	31.2 ± 0.2
1978-1979	10	11.3 ± 0.7	80	2.2 ± 0.4	31.3 ± 0.2	12	10.0 ± 1.2	25	2.3 ± 0.4	31.2 ± 0.3
1979-1980			25	1.7 ± 0.4	31.3 ± 0.3			20	2.5 ± 0.4	31.4 ± 0.3
1980-1981	16	10.5 ± 0.4	56	4.1 ± 0.3	31.1 ± 0.2	10	11.2 ± 0.5	39	4.2 ± 0.3	31.2 ± 0.3
1981-1982	11	11.2 ± 0.5	95	2.7 ± 0.2	30.5 ± 0.1	10	9.5 ± 0.5	28	3.0 ± 0.4	31.0 ± 0.3
1982-1983	11	12.7 ± 0.9	53	2.3 ± 0.3	31.3 ± 0.2	6	10.3 ± 0.6	41	2.4 ± 0.3	31.3 ± 0.2
Month of conception		***		***	*		**		***	NS
October-November	9	9.9 ± 0.5	79	1.1 ± 0.2	31.3 ± 0.1			44	1.3 ± 0.3	31.5 ± 0.2
December	21	9.1 ± 0.4	58	3.2 ± 0.3	30.9 ± 0.2			42	3.5 ± 0.3	31.3 ± 0.2
January	35	11.4 ± 0.3	88	4.1 ± 0.2	31.4 ± 0.1	6	8.9 ± 0.6	51	4.3 ± 0.3	31.3 ± 0.2
February	14	13.4 ± 0.4	82	3.2 ± 0.2	30.9 ± 0.1	43	9.8 ± 0.3	69	3.6 ± 0.2	31.0 ± 0.2
March	6	12.7 ± 0.6	61	2.5 ± 0.3	31.1 ± 0.2	20	12.5 ± 0.4	50	2.3 ± 0.3	30.8 ± 0.2
April and May			134	2.8 ± 0.2	31.3 ± 0.1			92	2.8 ± 0.2	31.3 ± 0.1
Parity				NS	NS				***	NS
1 st			90	2.6 ± 0.2	31.1 ± 0.1			65	2.4 ± 0.3	31.1 ± 0.2
2 nd			57	2.8 ± 0.2	31.0 ± 0.1			61	2.4 ± 0.3	31.2 ± 0.2
3 rd			99	3.0 ± 0.2	31.1 ± 0.1			67	3.2 ± 0.2	31.1 ± 0.2
4 th			69	3.2 ± 0.2	31.2 ± 0.1			54	3.7 ± 0.3	31.2 ± 0.2
5 th			65	2.9 ± 0.2	31.4 ± 0.2			35	3.6 ± 0.3	31.4 ± 0.2
> 6 th			73	2.4 ± 0.3	30.9 ± 0.2			66	2.7 ± 0.3	31.2 ± 0.2

N.S. = nonsignificant, * = $P < 0.05$, ** = $P < 0.01$ and *** = $P < 0.001$.

TABLE II

Estimates (σ^2) and proporations of variation (V %) of random components of variance , heritability (h^2) and repeatability (t) estimates for doe traits studied in Bauscat and Giza White rabbits.

Traits	Sire of doe		Doe / Sire		Remainder		h^2	t
	σ^2_S	V %	σ^2_D	V %	σ^2_e	V %		
Bauscat								
AFK	0.28*	15.6			1.51	84.4	0.62 ± 0.49	
NSC	a	0.0	0.05 NS	1.6	3.19	98.4	a	0.02 ± 0.03
GL	0.02 NS	1.2	0.20**	14.7	1.12	84.1	0.05 ± 0.08	0.16 ± 0.05
Giza White								
AFK	0.41*	22.9			1.40	77.1	0.91 ± 0.55	
NSC	0.13 NS	4.1	0.07 NS	2.2	3.00	93.7	0.17 ± 0.14	0.06 ± 0.04
GL	a	0.0	0.10 NS	6.4	1.47	93.6	a	0.06 ± 0.04

* = $P < 0.05$, ** = $P < 0.01$ and N.S = nonsignificant .

[a] Negative estimate of sire component of variance set to zero .