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# GENETIC AND NON-GENETIC FACTORS AFFECTING MILK YIELD OF RABBIT DOES UNDER HOT SEMI-ARID CLIMATE.

**SINGH G.**

Central Sheep and Wool Research Institute, AVIKANAGAR (via Jaipur) Rajasthan 304 501 - India

**ABSTRACT** : Forty five lactation records from 37 does of three breeds (White Giant: 16 ; Grey Giant : 12 and Soviet Chinchilla : 9) were analysed to study the effects of breed, parity, week of lactation and doe weight at kindling on milk production. ANOVA results showed that breed of the doe was important (P<0.07) for average weekly (600g) milk yield of the doe only and not for lactation (3600 g) yield, although White Giant does had numerically higher (625g per week and 3758g per lactation) production than did the does of other breeds. Effects of week of lactation, parity order and covariate of doe weight at kindling were significant in accounting for variation in milk yield. Peak of milk yield was reached in third (765g) week/18th day of lactation. Least squares means of doe body weight, litter size at birth and weaning and litter weight at birth and weaning were 3.10 ± 0.1kg, 6.5 ± 0.3 and 5.7 ± 0.3, 383.9 ± 16.5 and 3.7 ± 0.2kg, respectively. Of the 293 kits from 45 litters at birth, 255 kits were weaned resulting in overall pre-weaning mortality of 12.4 %. The average age at kindling was 11.0 months. Medium size but significant (P<0.05) residual correlation of milk yield with litter size (0.44) was observed. Other correlations of milk yield with litter size and weight at birth were low (0.21-0.29) and non significant. Lactation curves were unique to each breed and milk yield was influenced by several factors. Litter weight at birth and at weaning was influenced by all the above factors, except the non significant effect of doe weight on litter weight at birth.

***RÉSUMÉ : Facteurs génétiques et non génétiques affectant la production laitière des lapines en climat semi-aride.***

*Afin d'étudier les effets de la race, de la parité, du stade de lactation et du poids de la femelle à la mise bas sur la production laitière, 45 lactations de 37 lapines de trois races différentes (16 Géant Blanc, 12 Géant Gris et 9 Chinchilla Soviétique ) ont été enregistrées. Les résultats montrent que l'effet de la race de la lapine est significatif (P<0.07) pour la production laitière moyenne hebdomadaire (600g) seulement et non pour la production totale de la lactation (3600 g) bien que les lapines Géant Blanc aient une production plus élevée (625 g par semaine, 3758 g pour la lactation totale) que les autres races. Le stade de lactation, l'ordre de parité et le poids de la lapine à la mise bas ont un effet significatif sur la variation de la production laitière. La production laitière maximum est atteinte la troisième semaine de lactation (765 g). Le pic de production est observé au 18e jour. Les moyennes ajustées du poids vif des lapines, de la taille de la portée à la naissance et au sevrage et le poids le la portée à la naissance et au sevrage sont de 3,10 ± 0,10 kg, 6,5 ± 0,31 et 5,7 ± 0,29, 383,9 ± 16,5 g et 3,7 ± 0,19 kg respectivement. Sur 293 lapereaux nés appartenant à 45 portées, 255 ont été sevrés ce qui donne une mortalité avant sevrage de 12,4 %. L'âge moyen à la mise bas est de 11 mois. On observe une corrélation résiduelle moyenne mais significative (0,44 ; P<0,05) entre la taille de la portée et la production laitière. Les autres corrélations entre la production laitière et la taille de la portée et le poids à la naissance sont faibles et non significatives (0,21 - 0,29). Les courbes de lactation sont spécifiques de chaque races et la production laitière influencée par plusieurs facteurs. Le poids de la portée à la naissance et au sevrage sont influencés par tout les facteurs précédents, excepté un effet non significatif du poids de la lapine sur le poids de la portée à la naissance*

## INTRODUCTION

Milk yield in rabbits, as in other mammals, is an important maternal trait and may be affected by breed (COWIE, 1969 ; LUKEFAHR *et al.*, 1981 ; MCNITT and LUKEFAHR, 1990) lactation days (MCNITT and LUKEFAHR, 1990) and weight of doe at kindling (KAMAR *et al.*, 1985).

The objective of the present study was to study the effect of breed, parity, duration of lactation in weeks and weight at kindling on weekly milk yield under tropical conditions. The lactation yield for the two lactations was also studied for the above effects.

## MATERIALS AND METHODS

The data set consisted of 1890 records on daily milk yield of 45 lactations obtained from 37 does of White Giant (16), Grey Giant (12) and Soviet Chinchilla (9) breeds maintained under the Broiler Project of the Institute. The farm is located at longitude 75°-28° E, latitude 26°-26° N and altitude 320m above MSL in the semi-arid zone of sub-tropic India. The mean annual precipitation ranges from 400-600 mm and its distribution is mainly between July and September. The breeds were Grey Giant, White Giant and Soviet Chinchilla of Russian origin.

The does were housed in all-wire cages with attachment of nest-box. The dimensions of the doe cage were 45x50x38 cm and that of nest box was 30x50x38 cm. The cages were placed on single-tier of iron frame under the asbestos roofed-shed thached with reeds. The walls of the housing shed consisted of 4' wire mesh fixed on 60cm wall for free flow of air. The ambient temperature during the period under study averaged 22.1 ± 0.2 with a range from 19 to 26°C and

R.H. (Relative Humidity) ranged between 27.5 and 63.4 %. Protection against extreme cold or cold winds was provided with screens of gunny bags. A commercial concentrate with assured chemical analysis of 19.5 % C.P. and 7.0 % C.F. and fresh water were offered manually. No breeding was done during lactation. The doe and the litter were weighed within 24 hours of kindling.

The daily milk yield was determined as the difference between litter weight before and after suckling once in the morning over a seven month period extending from October 1990 to April 1991. The weekly milk yield was a total of daily milk production for a lactation period of 42 days. The same dams were separated from their young immediately after suckling which lasted for 3-5 minutes. The litters were maintained in the nest-box until day 14 after kindling after which they were maintained on all-wire cages. The weaning was done on 42nd day.

Data were subjected to least-squares analysis of variance (HARVEY, 1990) for studying the effects of breed, parity and week, including regression of doe weight at kindling according to the following mathematical model :

$$Yijkl = \mu + Bi + Pj + Wk + b(Xijkl - \bar{X}ijkl) + Eijkl$$

Where

Yijkl = observed value of a given dependent variable
$\mu$ = Over all mean
Bi = fixed effect of $i^{th}$ doe breed (i = 1, 2, 3)
Wk = fixed effect of $k^{th}$ week of lactation (k = 1, 2, 3, 4, 5, 6)
b = partial regression of milk yield on doe weight
Xijkl = doe body weight at kindling
$\bar{X}$ijkl = mean of Xijkl
Eijkl = random error

The average age of the doe (11 months) at kindling was observed to be non-significant and not included in the model.

A second analysis was performed to estimate the least-squares means and residual correlations among daily milk yield, doe body weight, litter size and weight at birth of live kits together with litter size and weight at weaning. The data set consisted of all available mean lactation records (n=45) and single measure of doe weight and litter productivity, as opposed to the daily records (n=1890).

The model 2 assumed was as follows :

$$Yijkl = \mu + Bi + +Fij + Pk + Eijkl$$

where

Yijkl = observed value of average daily milk yield
$\mu$ = Overall mean
Bi = fixed effect of $j^{th}$ doe breed (i = 1, 2, 3, 4, 5)
Fij = Random effect of the $j^{th}$ doe within the $i^{th}$ breed
Pk = Parity of the doe pooled across doe breed (k = 1, 2, 3)
Ejkl = random error

Among doe variation source served as the error line for the fixed effect of the doe breed.

## RESULTS AND DISCUSSION

The weekly and lactation milk yields are presented in Table 1. The overall least-squares means for daily, weekly and lactation milk yields were 85.8 ± 0.7, 600 ± 8 and 3600 ± 65 grams. The values were lower than those reported by KAMAR *et al.* (1985).

### Factors affecting the milk production

As shown in table 1, there were four major factors affecting the weekly and also daily (table not given) milk yield, viz. breed, parity of the doe and duration of

**Table 1 : Least-squares means of weekly and lactation milk yield ( g ± $s_m$ ; number of observations between brackets)**

| Effect | Weekly milk yield | Lactation milk yield |
|---|---|---|
| *Overall mean* | *600 ± 7.5 (270)* | *3600.4 ± 65.3 (45)* |
| *Breeds* | P = 0.0729 | NS |
| White Giant | 624.9 ± 12 (108) | 3757.7 ± 103.4 (18) |
| Grey Giant | 589.6 ± 12 (96) | 3560.6 ± 107.9 (16) |
| Soviet Chinchilla | 586.6 ± 16 (66) | 3483.0 ± 131.7 (11) |
| *Parity order* | ** | ** |
| First | 568.3 ± 9.9 (150) | 3396.4 ± 86.2 (25) |
| Second | 632.5 ± 11.1 (120) | 3804.4 ± 97.3 (20) |
| *Week of lactation* | ** | |
| First | 511.6 ± 17.9 (45) | - |
| Second | 699.8 ± 17.9 (45) | - |
| Third | 765.1 ± 17.9 (45) | - |
| Fourth | 649.8 ± 17.9 (45) | - |
| Fifth | 526.2 ± 17.9 (45) | - |
| Sixth | 449.7 ± 18.0 (45) | - |
| Regression of doe weight at kindling (g/kg live weight) | * 45.0 ± 20.9 | NS 175.5 ± 121.2 |

* P<0.05 ; ** P<0.01 ; NS non significant

lactation in weeks including the regression of doe body weight at kindling.

The model explained 51.7 % of the variability with a C.V. of 19.95 % in milk yield. Lactation milk yield was influenced by the parity only and is, therefore, not discussed much in the following paragraphs.

***Breeds :***

The effect of breeds on the milk yield of rabbits was significant ($P<0.01$) for daily milk yield and tended to be important ($P=0.0729$) for weekly milk yield. The breeds accounted for 1 % of the variation in weekly milk yield and 5.3 % in lactation yield. White Giant produced higher daily milk yield (89.2g/day) than Grey Giant (84.05g/day) and Soviet Chinchilla (84.09g/day) both of which producing similar milk yield. MCNITT and LUKEFAHR (1990) also did not observe the significant differences in milk yield of different breeds of rabbits.

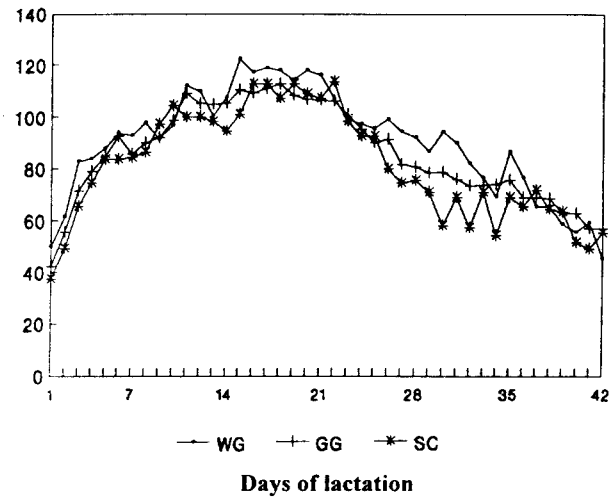
***Parity order at kindling :***

The order of lactation influenced the daily ($R^2=1.73$ %), weekly and lactation ($R^2=18.11$ %) milk yield significantly ($P<0.01$). The milk yield was maximum in the second parity (90.3g per day, 633g per week and 3804g per lactation) and was lowest in the primiparous (81.3g/day) does. ABU-EL-EZZ *et al.* (1981) and LUKEFAHR *et al.* (1983) also demonstrated increase in mean milk production as parity of the doe advanced.

***Duration of lactation :***

The weekly milk yield was significantly ($P<0.01$) influenced by the six weeks ($R^2=46.1$ %) and 42 days ($R^2=29.4$ %) of lactation period and contributed highest variation in milk production as compared to any other factor under study. The milk yield peaked in third week of lactation and declined gradually from fourth to sixth week. KAMAR *et al.* (1985) also reported similar observations. The raw means of daily milk yield plotted for the different breeds (Figure 1) showed that peak daily milk yield, on an average, was reached on 18$^{th}$ day. The peak daily milk yields were 122.2 (day 15), 113.7 (day 22) and 112.7 (day 18) grams for White Giant, Soviet Chinchilla and Grey Giant does. Further perusal of the lactation curve revealed that White Giant does had consistently higher milk yield than the other two breeds both of which produced similar milk yield. There appeared to be absence of breed differences in persistency, although Soviet Chinchilla does had the more rapid rate of decline in second peak (day 22) after reaching first peak at day 16 (112.7g). The White Giant appeared to maintain higher lactation levels for longer period. Thus does that exhibit greater persistency could wean heavier litters than does that have a faster decline in milk production. This is quite evident from analysis of litter weight at weaning wherein White Giant does weaned heavier litters (3.94 kg) as compared to other breeds as shown in Table 4. MCNITT and LUKEFAHR (1190) also reported breed differences in persistency and day(s) of peak yield ranging from 18.4 to 20.6 days for five breeds of rabbits.

**Figure 1 : Daily milk production (g) of three breeds**




***Doe weight at kindling :***

Doe weight at kindling, as a covariate was a significant source of variation in weekly (45g increase of milk yield per kg increase of doe weight) and daily (17g increase / kg increase of doe weight) milk yield but not in lactation milk yield. KAMAR *et al.* (1985) reported significant effect of doe weight on weekly milk yield.

***Doe breed means for daily milk yield and associated traits :***

Estimates of least-squares means of mean daily milk yield and related traits (Table 3) obtained by Model 2 revealed that breed of the doe was not significant source of variation in daily yield when the variation among does was used as error line. The degrees of freedom associated with F-test of significance for doe breed were 2,34. Parity exerted significant effect on mean daily milk yield. The variation among does within breed and that due to parity was significant for litter weight at birth and non-significant for the other five of the six dependent variables.

The mean daily milk yield was highest for White Giant and lowest for Soviet Chinchilla. BARTELLI and ALTOMONTE (1968) and LUKEFAHR *et al.* (1983)

**Table 4 : Least-squares means of litter weight at birth and weaning**

| Effect | Number of records | Litter weight at Birth (g) | Litter weight at Weaning (kg) |
|---|---|---|---|
| *Over all mean* | *45* | *363.4 ± 10.1* | *3.65 ± 0.14* |
| *Breeds* | | *NS* | *NS* |
| White Giant | 18 | 360.1 ± 14.4 | 3.94 ±0.19 |
| Grey Giant | 16 | 381.7 ±15.7 | 3.33 ±0.21 |
| Soviet Chinchilla | 11 | 348.3 ±21.8 | 3.70 ±0.30 |
| *Parity order* | | ** | * |
| First | 25 | 326.4 ±12.3 | 3.82 ±0.19 |
| Second | 20 | 400.4 ±14.8 | 3.49 ±0.20 |
| *L S B* | | ** | *NS* |
| up to 4 | 6 | 241.1 ±25.1 | 3.31 ±0.46 |
| 5 | 6 | 355.6 ±24.9 | 3.40 ±0.36 |
| 6 | 12 | 358.0 ±17.8 | 3.67 ±0.24 |
| 7 | 6 | 391.3 ±26.2 | 3.97 ±0.35 |
| 8 & plus | 15 | 470.8 ±15.8 | 3.91 ±0.27 |
| Regression | | NS | * |
| Independent variable | | DWK | LSW |
| | | 17.4 ±17.3 | 0.27 ±0.11 |

LSB = Litter size at birth ; LSW = Litter size at weaning ; DWK = Doe weight at kindling ; * = P<0.05 ; ** P<0.01 ; NS = non significant

reported the significant breed differences in milk yield as well as for doe weight, litter size born alive and weaned and litter weaning weight. Of the 293 kids born in 45 litters at birth, 255 kids were weaned resulting in an overall pre-weaning mortality of 12.4 %. These differences may be attributed to strains of breeds, breed x environment interaction, differing experimental methodologies or some combination thereof.

Residual correlations among daily milk production and associative traits (Table 3) estimated on within breed basis indicated that a modest correlation of 0.44 (P<0.01) existed between milk production and litter size at weaning.

**Table 3 : Residual correlations among productive traits**

| | Daily milk yield (1) | Doe body weight (2) | Litter size at birth (3) | Litter weight at birth (4) | Litter size at weaning (5) | Litter weight at weaning (6) |
|---|---|---|---|---|---|---|
| (1) | - | 0.22 | 0.29 | 0.22 | 0.44 | 0.21 |
| (2) | - | - | 0.13 | 0.17 | 0.22 | 0.12 |
| (3) | - | - | - | 0.82 | 0.79 | 0.59 |
| (4) | - | - | - | - | 0.64 | 0.49 |
| (5) | - | - | - | - | - | 0.66 |

**Factors affecting litter weight**

From inspection of the Table 4, it is observed that 71.2 % and 28.2 % variation in litter weight at birth and at weaning was accounted for by the model which included fixed effects of breed, parity and litter size at birth/weaning including doe's weight at kindling as covariate.

***Breed***

Breed differences were non-significant in litter weight at birth and at weaning, although Grey Giant (381 g) litters weighed heavier than White Giant (360 g) and Soviet Chinchilla (348 g) at birth.

***Parity order at kindling***

The lactation sequence had an important (P<0.01) influence on litter weight at birth ($R^2$ = 12 %) and not on weight at weaning ($R^2$ = 32 %).

There was considerable increase in litter weight at birth with increase in the parity order of the does from first to second lactation. Significant differences existed between the primiparous and multiparous does.

***Litter size at birth and weaning***

Due to smaller number, the litter sizes lower than 4 and higher than 8 were merged with respective litter size at birth and at weaning. Significant (P<0.01) effect of litter size at birth was observed on litter weight at birth and of litter size at weaning on litter

weight at weaning (LWW). As the number of suckling kits/weaners per doe increased, the litter weight at birth and at weaning increased linearly (b = 270 g increase in LWW for each additional weaner rabbit). Litter size at birth explained 54.43 % and 11.91 % of the variability in litter weight at birth and at weaning.

***Doe weight at kindling***

The doe's weight at kindling was not important (P>0.05) source of variation in litter weight at birth and weaning. The doe weight averaged 3.2 kg with a range from 2.84 to 3.5 kg.

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