Reproductive Performance of Rabbits Selected for Post-weaning Growth Rate

By

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Introduction

There is a special relationship between litter size and body weight. This relationship can be divided into 2 parts:

a. The relationship of the dam and her litter.

b. The relationship amongest the members of the litter.

Several studies reported on litter size in rabbits (Sittman, Rollins, Sittmann and Casady, 1964; Rollins, Casady, Sittmann and Sittmann, 1960; and Venge, 1963) and in various other species have indicated a favourable positive phenotypic correlation between post-weaning growth rate of the dam and the litter size she produces. It would be rather difficult to know the exact nature of this correlation because of the associated environmental artefacts mediated through the

dam (Castle, 1929; Venge, 1950; Yao and Eaton, 1954; Rollins and Casady, 1960; Leplege, 1970; Macarthur, 1949; Falconer, 1953; Bradford, 1971; and Wilson, 1973). Therefore, selection for increased growth rate is expected to increase litter size at birth. On the other hand, Doolittle, Wilson and Hulbert (1972) and El Amin (1974) showed that young born in larger litters tend to be smaller at birth and at weaning. Thus, selection for an increased post-weaning growth rate will produce larger litters but with smaller individual birth weights.

The present work is undertaken to show some litter traits and their association with other closely related characters. This will be useful in supplying information about their inheritance and about factors influencing them.

Material and Methods

Two strains of rabbits were obtained for this experiment. The first designated as NR, was a pure New Zealand White (NZW). The second strain, called PS, was a Californian breed. The New Zealand White strain was divided into 3 lines selected for different traits while the Californian strain was divided into 2 lines. The following description summarizes the lines on the selection criteria:

Line No.	Line designation	Description
1	GR	Selected for rapid post-weaning growth rate from NR strain.
2	GRX	Selected for rapid post-weaning growth rate initiated as a cross from GR males and PS females.
3	CL	Random bred control from NR strain.
4	PS	Random bred control from PS strain.

The means and standard deviation are presented for the traits studied. Males were mated to a group of 3 does each.

Results

a. Litters produced:

The number of does kindling and those weaning a litter each generation x lines is shown in Table 1.

Table 1. Number of does kindling[a] and weaning litters[b] by generation and line

Line / Gen.	GR a (b)	GRX a (b)	CL a (b)	PS a (b)
1	50 (34)	-	with GR	10 (6)
2	18 (17)	12 (9)	18 (14)	11 (9)
3	18 (17)	18 (17)	17 (16)	11 (8)
4	18 (16)	17 (15)	16 (15)	10 (9)
5	15 (13)	15 (14)	14 (9)	-

Since lines GR and CL originated from the same base, they were considered together in generation 1 under line GR for does weaning a litter.

The proportion of does which failed to wean a litter because it was either stillborn or lost prior to weaning varied between lines and generations. The largest loss was at generation 1 where only 68% of the does which kindled raised their litter and 32% lost their litters (Table 1). This has declined to less than 10% in later generations.

Litter size born has shown an increase in all the lines over the first two generations (Table 2). In all lines, there appears to be an upward trend in litter size when comparing the first and fifth generations except for the control, which remained almost at the level of the base population. The low values obtained for the GRX line in generation 5 could be due to sampling since fewer does kindled in that generation. Fig. 1 depicts the fluctuations which occurred in the average litter size in all lines and generations. The most prominant feature of the graph is the drop in mean litter size of the GR line at generation 4.

The overall mean litter size born for the first 4 generations was 7.30 young per litter while the number born alive was 6.84 young per litter.

The frequency of litter size born in each line in the different generations and the total of all lines and all generations are plotted in a histogram (Fig. 2). From the histogram we can see that the most frequent litters encountered were those with 6, 7 and 8 young per litter. In the lines where there was selection for growth rate (histogram 2F and G), there seem to be more litters with larger size than in the other lines. The crossbred line (E), also has its

Table 2: Average litter size born[a] and litter size born alive[b] in each line and generation.

Gen.	Line	GR	GRX	XL	PS
1	a	6.43 ± 2.31	-	with GR	6.21 ± 3.01
	b	(5.73 ± 2.90)	-		(5.96 ± 2.91
2	a	6.84 ± 3.10	7.00 ± 2.90	7.26 ± 2.56	5.90 ± 2.69
	b	(6.11 ± 3.07)	(6.69 ± 3.08)	(5.74 ± 2.70)	(5.60 ± 2.80)
3	a	8.72 ± 3.14	8.73 ± 2.30	6.47 ± 3.06	6.67 ± 3.00
	b	(7.94 ± 3.40)	(7.95 ± 2.52)	(6.23 ± 3.47)	(5.86 ± 2.90)
4	a	6.38 ± 2.60	8.83 ± 3.67	7.06 ± 3.54	7.10 ± 2.90
	b	(5.56 ± 3.18)	(7.33 ± 3.27)	(6.11 ± 3.85)	(6.90 ± 2.73)
5	a	7.38 ± 2.31	7.26 ± 3.04	6.33 ± 2.18	-
	b	(6.56 ± 2.73)	(7.04 ± 2.00)	(5.25 ± 2.09)	-

Figures in brackets represent number born alive.

frequent class at the highest level ($\geq$ 10 young). In the unselected lines, CL (D) and PS (A) small litters were quite frequent.

b. Size of litters weaned

The size of the litter weaned is an indication of the dam's direct contribution to production. Also, larger litters weaned mean more number available for testing and consequently higher selection intensities. The average numbers weaned per litter are shown in Table 3 for all lines and generations. When comparing generation 5 with the first generation there seems to be an improvement in average litter size at weaning. There was some moderate increase in the GR and GRX lines. Both the CL and PS lines remained almost at the initial level. The overall litter size weaned in all the lines for generation 1 to 4 was 5.47 young per litter. The coefficients of variation have indicated a fair amount of variability which can be utilized in selection (Table 4).

Table 3. Average litter size weaned by line and generation

Line / Gen.	GR	GRX	CL	PS
1	4.72 ± 1.95	-	same as GR	4.93 ± 2.10
2	5.24 ± 2.66	4.90 ± 2.40	4.79 ± 2.15	4.01 ± 3.09
3	5.48 ± 2.44	6.64 ± 1.90	5.76 ± 1.78	4.63 ± 2.90
4	5.43 ± 1.83	6.47 ± 1.25	4.93 ± 2.28	5.33 ± 2.42
5	5.69 ± 2.59	6.67 ± 2.50	4.80 ± 2.08	-

Table 4. Coefficients of variation in per cent for litters born of the lines in each generation.

Line / Gen.	GR	GRX	CL	PS
1	35.90	35.90	35.90	48.50
2	35.10	41.43	40.89	45.60
3	36.01	26.35	47.60	45.00
4	43.90	41.60	50.10	41.10
5	31.30	41.90	34.40	-

c. Age at first kindling

This is one of the measures of the reproductive ability of the females and probably of the males as well (since both are mated at about the same age), but this was not tested. It is also the generation interval from the birth of the does to the birth of their first offspring.

From Table 5, it can be seen that there is a decrease in age at first kindling in all lines except for the GRX line. Age at first kindling decreased between generation 1 and 5 by 8 days for the average of the lines. However, the GR line reached sexual maturity earlier than the other lines ($P < .05$). The last to kindle was the GRX line. This could be attributed to the fact that the GRX lines was heavier in body weight which might have delayed its sexual maturity (Table 6).

Table 5. Age at kindling first litter by generation and line

Line / Gen.	All lines	GR	GRX	CL
1	162 ± 14	162 ± 14	-	162 ± 14
2		177 ± 18	-	178 ± 15
3		163 ± 16	156 ± 13	160 ± 22
4		149 ± 19	172 ± 22	163 ± 20
5	154 ± 15	151 ± 16	165 ± 12	158 ± 16

Table 6. Weight at mating of males (M) and females (F) and weight of females at birth of litter (gm).

Gen.	3		4		5	
Line	M	F	M	F	M	F
Mating weight						
GR	2936	3430	3101	3295	3191	3433
GRX	3034	3660	3390	3490	3492	3537
CL	2860	2967	2857	2996	2791	3020
Weight at birth						
GR		-		3590		3697
GRX		-		3816		3766
CL		-		3431		3490

d. Inbreeding

The effective population size intended for all the lines (6 males and 18 females) is expected to be 18.05 with an increment in inbreeding (ΔF) of 0.0277 each generation. Up to generation 5, the cumulative inbreeding from the expected effective population number would be 0.[illegible]610 for each line.

Actual inbreeding coefficient calculated from the effective number of breeders in the selected lines at generation 5 was as follows:

GR line: 0.1309; GRX line: 0.1161; CL line: 0.240 and
PS line: 0.1756 at generation 4.

The departure from the expected values due to inbreeding was not large indicating that inbreeding did not cause serious deterioration of reproductive performance. This was supported by a lower level of inbreeding calculated from the pedigree (5 - 8%).

Discussion

Generally, litter size in rabbits varies between breeds and strains within breeds. In this study litter size was larger than that reported by Rollins et al. (1960) for New Zealand Whites.

In animals which have their young in litters, there is a special relationship between litter size and body weight. Young born in larger litters tend to be smaller at birth and at weaning. Furthermore, selection for high post-weaning weight gain (lines GR and GRX) will automatically produce genotypes which increased mature weights (Sollar and Moav, 1973). A larger mature body weight (Table 6) will provide an improved maternal environment, thus increasing litter size in the following generation (Fig. 2E).

There seems to be an overall improvement in litter size over the initial generation. It is usually expected that inbreeding will have a detrimental effect in small populations especially in reproductive performance but it seems that the mating plan avoided a high level of inbreeding at that stage. However, inbreeding and genetic drift are more important over the long term. It can be seen from the evidence on litter size born (Table 2) and litter size weaned (Table 3) that selection for post-weaning growth (lines GR and GRX) had increased these traits. Falconer (1965) has explained the relationship between litter size born of the dam and body weight of the daughter. The maternal effect alternates between the negative influence of the dam on body weight of her daughters and the positive correlation of the daughters' body weight and their litter sizes. He suggested standardizing litter size to remove this negative environmental effect.

In conclusion, selection for post-weaning growth rate has led to a correlated response in litter size which resulted in an increase in number born per litter.

Since does feed their young once per day, it seems that there is an optimum litter size of eight young per litter. This will coincide with the average number of eight teats per doe.

Summary

A selection experiment involving two strains of rabbits, a New Zealand White (NE) and a Californian (PS) were divided into several lines selected for post-weaning growth rate between 30 and 60 days of age. In each of the lines GR; GRX and CL six males were each mated to three females while in the PS line there were four males each mated to 3 females.

Litter size born averaged 7.30 young/litter and litter size born alive averaged 6.84 young/litter over all the lines. It has shown a correlated response to selection for rapid post-weaning growth rate. The coefficient of variation for litter size born was high indicating a large variability in the trait.

Litter size weaned 5.47 young/litter over all the lines and generations showed some improvement over the initial levels. It was also shown that inbreeding had little effect on litter traits indicating the success of the mating plan in avoiding inbreeding at the initial generations. There was a correlated response in age at first kindling to selection for rapid post-weaning growth rate.

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Fig. 1

LITTERSIZE BORN BY GENERATIONS AND LINES.

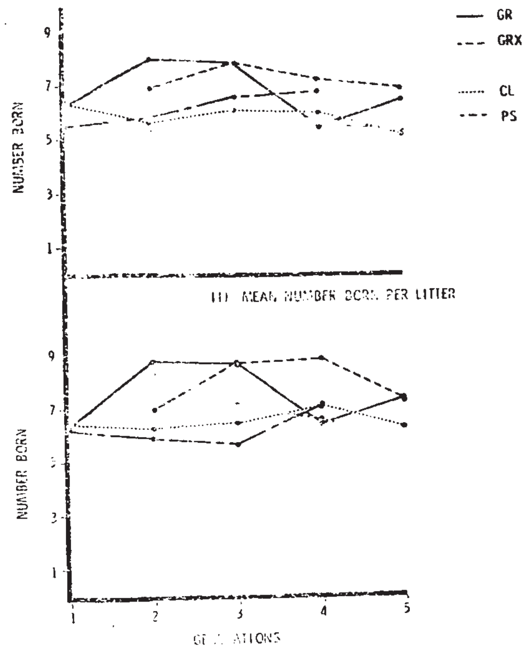

Fig. 2

HISTOGRAMS OF NUMBER BORN.