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SELECTION RESPONSE ON REPRODUCTIVE CHARACTERS IN A MATERNAL LINE OF RABBITS*

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ABSTRACT

Line V is a maternal line of rabbits, selected for litter size at weaning for 21 generations. Embryos from generation 15 were frozen and thawed to be contemporary of rabbits of generation 21 in order to estimate the response to selection in reproductive traits. After six generations of selection, direct response for litter size at weaning was significant and positive. The females of generation 21 had 0.53 weaned young rabbits more than females of the generation 15. Moreover, the females of the generation 21 had advantages with respect to females of the generation 15 of 1.08 in ovulation rate, 0.61 in total litter size at birth and 0.58 in number of born alive. Nevertheless, our experiment has failed to prove that the number of implanted embryos, number of dead foetus, implantation rate, foetus survival, prenatal survival, litter size at 10 days and 63 days of age, live litter weight at birth and kindling interval have been modified after six generation of selection on litter size at weaning, probably because the size of the experiment was to low for these traits.

INTRODUCTION

The selection objective of several experiments of rabbit breeding is litter size (Rochambeau, 1988; Estany et al, 1989) because litter size at birth, weaning or slaughter are important traits in the economy of rabbit meat production (Armero y Blasco, 1992).

An important issue in these experiments is to evaluate the genetic response on the trait selected for and on other traits.

Different methodologies have been used to estimate the genetic response:

Without control population, Sorensen and Kennedy (1984) used mixed model methodology to estimate the genetic response, but the results obtained with this method is highly dependent on the genetic parameters and model used (Thompson , 1986).

Others methods make use of a control population raised contemporaneously and under the same environment than the selected population. Some reproductive techniques as cryopreservation of semen or embryos (Smith, 1988), avoid the disadvantages of maintaining a control population without selection because they allow the contemporaneous comparison with animals of distant generations.

The aim of this paper is to study the selection response in a line of rabbits selected for litter size at weaning on reproductive traits comparing animals pertaining to two generations, six generation apart, coming the rabbits of the older generation from vitrified embryos.

MATERIAL AND METHODS

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Line V is a synthetic maternal rabbit line selected since 1984 for litter size at weaning with a BLUP under a repeatability animal model (Estany et al, 1989). Two types of does were used in the experiment:

1.- does coming from generation 15 of line V (V15).

There were two groups of females. Some females (V15V) were obtained after transfer of vitrified embryos (García et al, 1998) and in order to avoid the vitrification effect, daughters of these females (V15N), obtained from natural mating between females and males of group V15V, were also controlled.

The type of doe V15 was constituted with does V15V and V15N.

2.- does coming from generation 21 of line V (V21).

At the end of the generation 21 of selection, the embryos belonging to the last fertile mating of the females were vitrified, thawed and transferred. The females coming from this process were the group V21V. At the same time, the non selected female progeny of generation 21 was the group V21.

The type of doe V21 was constituted with does V21V and V21N.

The does were placed in five different farms:

1.- Farms 1 and 4 are nucleus farms. Females of line V of the generation 15 or 21 were mated to males of line V of the generation 15 or 21, respectively.

2.- Farms 2, 3 and 5 are commercial farms in which females of line V were mated to or artificial inseminated with males of line R. Line R is a paternal line selected for postweaning daily gain (Estany et al, 1992).

The number of animals of each group in the farms is shown in table 1. Only farms 1 and 4 had V15V and V21V.

Table1.-Number of does with reproductive data.

TYPE OF DOE	TOTAL	FARM 1	FARM 2	FARM 3	FARM 4	FARM 5
V15V	73	38	-	-	35	-
V15N	167	-	52	59	-	56
V21V	36	24	-	-	12	-
V21N	335	154	58	57	8	58

V15V does coming from vitrified embryos of generation 15 of line V. V15N does of the generation 15 of line V. V21V does coming from vitrified embryos of generation 21 of line V. V21N does of the generation 21 of line V.

The following traits were recorded:

Total litter size at birth (**TB**), litter size born alive (**BA**) and kindling interval (**KI**) were recorded in all farms and also litter size at weaning (**NW**), except for farm 5.

In females of the farms 1 and 4, a laparoscopy (Molina, 1987) was performed on pregnant does in their second and third gestation, 12 days after mating. The characters studied were: ovulation rate (**OR**) estimated as number of corpora lutea, number of implanted embryos (**EN**), number of dead foetus estimated as number of embryos minus litter size at birth (**NDF=NE-TB**), implantation rate estimated as **EN/OR**, foetus survival estimated as **TB/EN** and prenatal survival estimated as **TB/OR**. Moreover, live litter weight at birth (**LLWB**), litter size at 10 days of age (**N10**) and litter size at 63 days of age (**N63**) were also recorded.

Statistical analysis

The traits ovulation rate, number of implanted embryos, number of dead foetus, implantation rate, foetus survival and prenatal survival have been analysed by an animal model.

$Y_{ijklmn} = m + Td_i + Vit_j + Fys_k + Ps_l + pe_{ijklm} + a_{ijklm} + e_{ijklmn}$ where,

- m is the population mean.
- Td_i is the type of doe, fixed effect with 2 levels, V15 and V21.
- Vit_j is the vitrification effect, fixed effect with 2 levels, does coming from vitrified embryos (vit=1) or from natural mating and gestation (vit=2).
- Fys_k is the fixed effect farm-year-season with 5 levels; 2 year-seasons for farm 4 and 3 year-seasons for farm 1.
- Ps_l is the physiological state of the doe, fixed effect with 2 levels, second or third gestation.
- pe_{ijklm} is the permanent non additive effect of the doe (random).
- a_{ijklm} is the additive value of the doe (random).
- e_{ijklmn} the residual of the model.

Live litter weight at birth, total litter size at birth, number of born alive, litter size weaning, at 10 days and 63 days of age have been analysed with the same model described above but physiological state of the doe had 5 levels: nulliparous, primiparous lactating and no lactating and multiparous lactating and no lactating does. The fixed effect, farm-year-season had 8 levels for LLWB, N10 and N63, 18 levels for TB and BA, and 15 levels for NW. Kindling interval was analysed with the same model, but only with fixed effects and 16 levels for farm-year-season.

All the models have been solved using PEST software package (Groeneveld, 1990). The variance component ratios for traits OR; EN; NDF; EN/OR; TB/EN; TB/OR, TB; BA; NW needed to solve the models have been taken from Gómez (1994) and Argente (1996). Tables 2 and 3 show these genetic parameters.

Table 2.- Genetic parameters of ovulation rate (OR), number of implanted embryos (EN), number of dead foetus (NDF), implantation rate (EN/OR), foetus survival (TB/EN) and prenatal survival (TB/OR).

CHARACTER	OR	EN	NDF	EN/OR	TB/EN	TB/OR
h^2	0.35	0.20	0.15	0.10	0.05	0.15
p^2	0.05	0.10	0.10	0.10	0.10	0.10

h^2 , heritability: p^2, ratio of permanent doe effects to phenotypic variance.

Table 3.- Genetic parameters of total litter size at birth (**TB**), number of born alive (**BA**), litter size at 10 days of age (**N10**), number of weaned (**NW**), litter size at 63 days of age (**N63**) and live litter weight at birth (**LLWB**).

CHARACTER	TB	BA	N10	NW	N63	LLWB
h^2	0.08	0.08	0.06	0.06	0.06	0.15
p^2	0.07	0.07	0.06	0.06	0.05	0.10

h^2 , heritability: p^2, ratio of permanent doe effects to phenotypic variance.

Differences between types of does (V21-V15) have been investigated testing the significance of the contrasts between them.

RESULTS AND DISCUSSION

The number of records and the main performances of does for each trait are presented in Tables 4 and 5. A total of 203 laparoscopies have been carried out in this experience. In general, ovulation rate, number of implanted embryos and prenatal survival are higher than values of bibliography. Hulot y Matheron (1980) reported ovulation rates of 13.1 and 11.2 for some populations of California and New Zealand breeds, Bolet et al (1990) gave values of 14.5 and 13.8 for the lines 2066 and 1077 in the gestation 4th.

The reported litter size at weaning in lines selected for this trait was 7.5 in line 1077 (Brun et al, 1992), 7.2 in line A (Feki et al, 1996) and 8.1 in line P (Ramon et al, 1996). These values are similar or lower than in line V (8.1,Table 5).

Table 4.- Number of records, maximum, minimum, average and standard deviation of ovulation rate (OR), number of implanted embryos (EN), number of dead foetus (NDF), implantation rate (EN/OR), foetus survival (TB/EN) and prenatal survival (TB/OR).

CHARACTER	OR	EN	NDF	EN/OR	TB/EN	TB/OR
N. REC	201	203	182	203	182	180
MAX	22	20	12	1	1	1
MIN	8	1	0	0.10	0.15	0.13
AVG	15.0	13.1	2.8	0.87	0.79	0.69
STD	2.6	3.1	2.5	0.17	0.17	0.21

Table 5.- Number of records, maximum, minimum, average and standard deviation of total litter size at birth (TB), number of born alive (BA), litter size at 10 days of age (N10), number of weaned (NW), litter size at 63 days of age (N63), live litter weight at birth (grams, LLWB) and kindling interval (days, KI).

CHARACTER	TB	BA	N10	NW	N63	LLWB	KI
N. REC	2203	2203	581	1639	854	562	1596
MAX	17	17	16	15	15	930	128
MIN	1	0	0	0	1	50	31
AVG	10.2	9.4	9.0	8.1	7.5	550	48
STD	3.0	3.5	2.8	3.0	3.0	146	11

Table 6 shows the comparison for reproductive traits before birth. There are significant differences in ovulation rate between V21 females and V15 females. The value of this difference is 1.08±0.62 ($P<0.10$) favouring V21 females.

There are not significant differences between types of does for number of implanted embryos, number of dead foetus, implantation rate, foetus survival and prenatal survival. So, the litter size at birth, higher in females V21 than in females V15 is due to a higher ovulation rate.

Table 7 reports the contrast between V21 females and V15 females in reproductive traits after birth. The females of the generation 21 have advantages with respect to the females of the generation 15 in total litter size at birth (0.61±0.26), number of born alive (0.58 ± 0.30) and at weaning (0.53 ± 0.26). However, the estimated contrast for litter size at 10 days was not significant probably due to a lower number of records for this trait than for litter size at other stages and the higher standard error.

The selection for litter size at weaning has been successful after six generations of selection and the response per generation is 0.088 weaned young. These results are higher than the genetic trend obtained in line V (0.033 rabbits weaned per generation) by Baselga et al (1992), using mixed model methodology.

Poujardieu et al (1994) estimated a genetic progress of 0.06 rabbits weaned per generation in line 1077 in relation with a non selected population and Gómez et al (1996) of 0.09 weaned rabbits per year in the maternal line P with methodology BLUP/REML.

No significant differences between both types of does were detected in litter size at 63 days of age and live litter weight at birth, but the number of records for these traits was lower than for total litter size at birth, number of born alive and number of weaned.

The kindling interval or days among delivery and mating is similar in both types of does. The unproductive period of the females don’t increase with higher litter size.

Table 6.- Contrast and standard error between types of does for traits: ovulation rate (OR), number of implanted embryos (EN), number of dead foetus (NDF), implantation rate (EN/OR), foetus survival (TB/EN) and prenatal survival (TB/OR).

CHARACTER	OR	EN	NDF	EN/OR	TB/EN	TB/OR
V21-V15	1.08*±0.62	0.74±0.69	0.05±0.53	1.14±3.51	2.18±3.61	0.34±4.58

*P<0.10%. V21, does coming from 21 generation of line V. V15, does coming from to 15 generation of line V.

Table 7.- Contrast and standard error between types of does for traits: number of total born (**TB**), number of born alive (**BA**), litter size at 10 days of age (**N10**), number of weaned (**NW**), litter size at 63 days of age (**N63**), live litter weight at birth (**LLWB,** g) and kindling interval (**KI**, days)

CHARACTER	TB	BA	N10	NW	N63	LLWB	KI
V21-V15	0.61**±0.26	0.58*±0.30	0.62±0.41	0.53**±0.26	0.54±0.42	28.1±22.4	0.27±0.35

*P<0.10%, **P<0.05%. V21, does coming from 21 generation of line V. V15, does coming from 15 generation of line V.

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