EVALUATION OF SEVEN BREED GROUPS OF RABBITS FOR LITTER TRAITS

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Abstract - A total of 421 inseminations were carried out corresponding to the first three parities of seven breed groups. Breed groups were New Zealand White (NZ), Californian (CA) and German Large White (GL) as purebreds and NZ x CA, CA x NZ, GL x F1 {GL x (NZ-CA) or GL x (CA-NZ)} as terminal crossbred (TX) and F1 x F1 as crossbreeds. Evaluation criteria included conception rate, total litter size born and litter size born alive, litter birth weight, litter size and weight at 21days, litter size and weight at weaning (6 weeks of age) and pre-weaning mortality.

There were not significant differences among breed-groups for all traits studied except litter birth weight ($P \leq 0.05$), total litter size born and litter weight at 21 days ($P \leq 0.10$). Purebred GL showed the highest performance in all traits except pre-weaning mortality. Crossbred litters of CA x NZ had the lowest pre-weaning mortality rate. The NZ purebred had the lowest performance in all traits (except conception rate). There were highly significant differences ($P \leq 0.01$) among parities for all traits except conception rate (the 3rd litter had the highest rate). However, the 1st litter had the smallest litter size and lightest litter weight in all times.

Direct heterosis (H^E NZ × CA) percentage for litter traits were low at birth (litter size and litter weight), while high estimates of heterosis were recorded for litter traits at weaning (litter size and litter weight). Heterosis percentages for litter traits ranged from zero percent to 7.9 % at birth and from 10 % to 17.7 % at weaning. Conversely, maternal heterosis (H^M NZ × CA) percentage for litter traits were high at birth (litter size and litter weight), while low estimates of heterosis were recorded for litter traits at weaning (litter size and litter weight). Maternal heterosis for litter traits ranged from 5.5 % to 12.5 % at birth and from 0.6 % to 5.5 % at weaning. Crossing of NZ with CA was associated with a reduction in pre-weaning mortality.

INTRODUCTION

Crossbreeding makes possible the optimum exploitation of the general and specific combining abilities of breeds. Combining ability contributes to the quantity of rabbit meat produced. The aim of the final cross is to produce larger numbers of rapidly growing crossbred rabbits than could be produce by purebreeding.

Hitherto, few studies have been published on the genetic comparison between purebred and crossbred does of rabbits for reproductive traits (PARTRIDGE et al., 1981 ; LUKEFAHR et al., 1983 and 1984 ; SALEH et al., 1988 ; MCNITT and LUKEFAHR, 1990 ; OZIMBA and LUKEFAHR, 1991 ; BRUN et al., 1992 ; NOFAL et al., 1995 and SZENDRO et al.,1996). There are not investigations dealing with evaluation of purebreds, single crossing, terminal crossing and the second crossbred generation under the same conventional conditions. As a prospective terminal sire line, the German Large White (GL) has been identified as a breed with high productive and reproductive abilities in Hungary (GIPPERT, 1994).

The purpose of the present study is to compare seven breed groups (three pure breeds, two reciprocal crosses, terminal cross and second crossbred generation) for litter traits. The effect of parity on litter traits and the interaction between breed groups and parity were also evaluated. The estimation of direct and maternal heterosis percentages for these characters as a genetic parameters in crossbreeding of NZ and CA rabbits were also examined.

MATERIAL AND METHODS

Breeding animals were three rabbit breeds : New Zealand White (NZ), Californian (CA) and German Large White (GL), and NZ x CA, CA x NZ, GL x F1 and F1 x F1 as crossbreeds. F1 bucks and does of single crossing (reciprocal crosses) between NZ and CA breeds were crossed earlier to produce F2 progeny and to terminally cross F1 does with GL bucks to produce crossbreeds (TX).

The experimental work was conducted at the rabbit breeding farm of the Research Institute For Small Animal Breeding, Gödöllő, Hungary in the period from December 1994 to June 1995. Young does were mated for the first time between 5-7 months of age in all groups. Number of breeding animals at the beginning of the experiment are presented in Table 1.

Table 1 : System of mating and number of breeding animals at the beginning of experiment.

Genetic group	Sire[a]	No. of Sires	Dam[a]	No. of Dams	Symbol
1	NZ	4	NZ	32	NZ
2	CA	3	CA	20	CA
3	GL	3	GL	23	GL
4	NZ	3	CA	20	NZ x CA
5	CA	4	NZ	32	CA x NZ
6	GL	4	F1	33	TX
7	F1	4	F1	32	F2

[a] NZ = New Zealand White, CA = Californian, GL = German Large White and F1 = New Zealand White x Californian or Californian x New Zealand White.

All animals were exposed to the same environmental conditions. The feed was a commercial diet containing 17 % crude protein and 14.87 % crude fiber. Rabbits were fed *ad libitum* and water was supplied through an automatic system.
Animals were housed in suspended cages of a commercial type and a nest box was provided for each doe on the 25th day of pregnancy. A thin layer of sawdust was placed in the bottom of the nest box. The experiment buck : doe ratio was 1 : 7-8 by using fresh semen and A.I. Data of the first three litters (354 litters of 421 female rabbits inseminated) were evaluated. Does which failed to be pregnant were removed at reinsemination. Young rabbits were weaned at six weeks of age. Conception rate (CR), total litter size born (LSB), litter size born alive (LSA), litter birth weight (LWB), litter size at 21 days (LS21), litter weight at 21 days (LW21), litter size at weaning (LSW), litter weight at weaning (LWW) in grams and pre-weaning mortality (PWM) were recorded. Pre-weaning mortality was calculated as a percentage of dead young at weaning to the total litter size born.

Statistical methods

Data were analyzed through least squares ANOVA procedures as described by Harvey (1987). The following model was used:

$$Y_{ijk} = \mu + G_i + P_j + (GP)_{ij} + e_{ijk}$$

where, Y_{ijk} the observation on the ijk^{th} litter.

μ = overall mean, common element to all observations,
G_i = fixed effect of i^{th} breed group (i = 1, 2 .and 7),
P_j = fixed effect of j^{th} parity (j = 1, and 3),
$(GP)_{ij}$ = interaction between i^{th} breed group and j^{th} parity, and
eijk = random deviation of all the other effects not specified in the model.

Heterosis Estimation

Heterosis percentages were estimated for $H^E_{NZ \times CA}$ (direct heterosis) and $H^M_{NZ \times CA}$ (maternal heterosis) according to DICKERSON (1969) by using breed-group least-squares means as follows : -

Direct heterosis effect (%) :

$$H^E_{NZ \times CA} = \{[(NZ \times CA) + (CA \times NZ) - (NZ \times NZ) - (CA \times CA)] / [(NZ \times NZ) + (CA \times CA)]\} * 100$$

Maternal heterosis effect (%) :

$$H^M_{NZ \times CA} = \{[\, 2 * (NZ - CA) \times (CA - NZ) - (NZ \times NZ) - (CA \times CA)] / [(NZ \times NZ) + (CA \times CA)]\} *100 - 0.5\, H^E_{NZ \times CA} (\%).$$

where, H^E and H^M represent direct heterosis and maternal heterosis effects, respectively, of NZ and CA breeds in this experiment.

RESULTS AND DISCUSSION

Breed-group effect

Breed-group least squares means for litter traits are given in Table 2. There were not significant differences ($P \geq 0.10$) among breed-group means for litter traits except in terms of LSB, LWB ($P \leq 0.05$) and LW21. Results of comparisons between purebred litters reflected combined direct and maternal breed effects, while results of comparisons between crossbred and purebred litters involved genetic effects attributable to breed as well as heterotic contributions. The GL purebreds had the largest litter size born alive and heaviest litter birth weight followed by F2, despite the F2 having the largest total litter size born (8 does kindled large litters of 14-16 young). NZ purebreds had the smallest total litter size born and litter size born alive. Single crossings of NZ x CA had higher total litter size born and litter size born alive than its reciprocal cross; on the other hand in CA x NZ crossbred litters the pre-weaning mortality was lower than its reciprocal crossbred litters during the period from birth to weaning. These results are in agreement with OZIMBA and LUKEFAHR (1991). Crossbred does of reciprocal crosses between NZ and CA surpassed their purebreds and single crossings for total litter size born and litter size born alive and litter birth weight (Table 2). The increase of total litter size born and litter size born alive as well as litter birth weight and litter weight at 21 days in crossbred groups over that of NZ and CA pure breeds indicated the superiority of the crossbred dam and could explain the positive role of maternal effects in determining litter size and weight. Based upon our results, the maternal breed effect appeared to be much more important than direct sire effects in influencing preweaning mortality. BRUN et al. (1992) found that single crossing generally failed to improve litter size, conversely double crossing through the use of crossbred dams improved litter size dramatically because of high maternal heterosis effects. The differences observed among breed groups in terms of LWB and LW21 are related partly to the litter size, namely, there is a positive correlation between litter size and litter weight (SZENDRO et al., 1988; KROGMEIER and DZAPO, 1991).

Table 2 : Least-squares breed-group and parity means as well as heterosis percentages for litter traits

Item	No	CR %	LSO	LSA	LWB (g)	LS21	LW21 (g)	LSW	LWW (g)	PWM
μ	354	84.3	8.38	7.37	446	5.93	1678	5.52	5791	35.7
Breed-group										
NZ x NZ	59	85.5	7.7^{c}	6.5	386^{b}	5.1	1585^{b}	4.8	5387	39.5
CA x CA	29	79.2	8.3^{abc}	7.4	436^{b}	5.8	1447^{b}	5.1	4899	39.3
GL x GL	46	90.5	8.8^{ab}	8.0	529^{a}	6.5	2032^{a}	5.9	6631	32.8
NZ x CA	34	78.3	8.2^{abc}	7.3	451^{ab}	5.8	1699^{ab}	5.6	6162	30.8
CA x NZ	62	89.2	7.8^{bc}	7.2	436^{b}	6.2	1697^{b}	5.8	5943	29.2
GL x F1	66	86.0	8.8^{ab}	7.4	431^{b}	6.1	1666^{b}	5.7	5826	39.4
F1 x F1	58	81.0	9.0^{a}	7.8	450^{b}	6.0	1616^{b}	5.6	5686	39.0
Parity										
1	156	83.6	6.9^{B}	5.8^{B}	355^{B}	4.3^{C}	1360^{B}	4.0^{C}	4546^{B}	46.7^{C}
2	115	82.9	9.1^{A}	8.2^{A}	488^{A}	6.3^{B}	1773^{A}	5.8^{B}	6263^{A}	35.4^{B}
3	83	86.2	9.1^{A}	8.1^{A}	494^{A}	7.2^{A}	1900^{A}	6.8^{A}	6563^{A}	25.1^{A}
Heterosis %										
H^{E} NZ x CA		1.7	0.0	4.3	7.9	10.0	12.0	15.2	17.7	-24.0
H^{M} NZ x CA		-2.5	12.5	10.0	5.5	5.0	0.6	5.5	1.7	-13.0

*: Litter traits abbreviations are : CR = Conception rate; LSO = total litter size born ; LSA = litter size born alive ; LWB = litter birth weight ; LS21 = litter size at 21 days ; LW21 = litter weight at 21 days ; LSW = litter size at weaning ; LWW = litter weight at weaning, and PWM = pre-weaning mortality.

Least-squares breed-group and parity means having the same small or capital letter within each column are not significantly different ($P \geq 0.10$ or 0.01 resp.).

Parity effect

Parity is a broad source of variation affecting litter traits at all times (Table 2). Highly significant differences ($P \leq 0.01$) among parities on litter traits (except conception rate) were observed in our results. The 3rd parity was the highest conception rate, a largest in litter size and heaviest litter weight but did not differ from the 2nd parity for all litter traits except LS21 and LSW. The 1st litter had the smallest litter size and lightest litter weight at all times. Significant parity effects on total litter size born and litter size born alive, at 21 days and at weaning were observed in our results and was detected also by AFIFI et al. (1982). Moreover, significant parity effects on pre-weaning mortality as shown in our experiment might be attributed to confounding between parity and season of birth. Variation in litter weights measured during this period for three parities may be associated with the lactation ability of the doe as well as her ability to care and suckle her young till weaning. Similar findings were detected by MCNITT and LUKEFAHR (1990). OZIMBA and LUKEFAHR (1991) also reported significant relationship between litter size and litter weight in rabbits ; who demonstrated that the increases in milk production as parity advanced which indirectly affect on litter weight up to weaning.

Breed-group by parity interaction

All traits were not significantly affected by breed-group x parity interaction. Therefore, any breed group could be used in an indefinite parity may be of considerable advantage. Similar results were concluded by KHALIL et al. (1995).

Heterotic effects

Estimates of direct heterosis (calculated as percentages) for litter traits are given in Table 2. These estimates indicated that crossing between NZ and CA rabbits was usually associated with an existence of heterotic effects on litter traits studied. Positive and high estimates were observed for litter traits at 21 days and at weaning (LS21, LW21, LSW and LWW), while low estimates of heterosis were recorded for litter traits at birth (LSO, LSA and LWB). Direct heterosis percentages for litter traits ranged from 10 % to 17.7 % at weaning while from zero to 7.9 % at birth. Moreover, crossing of NZ with CA was associated with a reduction in PWM and little improvement in CR (Table 2). The positive effect of crossing between NZ and CA breeds on litter size and weight at weaning and an improvement in pre-weaning viability was reported by PARTRIDGE et al., (1981) ; LUKEFAHR et al., (1983 and 1984) ; BRUN and ROUVIER (1988) ; NOFAL et al., (1995) ; KHALIL et al., (1995) and SZENDRO et al., (1996).

Maternal heterosis (calculated as percentages) of crossbred does of NZ with CA for litter traits were estimated also (Table 2). Positive and high estimates of maternal heterosis for litter traits at birth, while low maternal heterosis for litter traits at weaning. This means that using of crossbred does (NZ with CA) gives an advantage in litter performance in terms of larger litter size at birth along with lower mortality rate, reflecting non-direct genetic effects as well as maternal ability than purebred does. Similar to these results was reported by BRUN and ROUVIER (1988). Thus, litters from crossbred does (NZ x CA or CA x NZ) accumulate some direct and non-direct favourable genetic effects. The variation of litter traits at birth may be due to ovulation rate, ova wastage, implantation sites, embryonic mortality, embryo survival, foetal survival, utrine capacity and intra-utrine environment as reported by HULOT and MATHERON (1979). While, at weaning, litters are largely dependent upon the maternal care provided by the dam to her young during the suckling period.

In general, maternal effects appear to be more important than direct effects in influencing on most litter traits. Therefore, it could be concluded that for breeders of NZ and CA breeds: by using crossbred does of CA and NZ rabbits total litter size born and litter size born alive, litter birth weight, litter size at 21 days, litter size at weaning and viability of youngs till weaning can be improved.

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