Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 480-488..

THE REPRODUCTIVE EFFICIENCY OF BUCKS IN DIFFERENT GENOTYPES

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ABSTRACT

The reproductive efficiency of bucks in different genotypes, using single and heterospermic artificial insemination is considered.
479 inseminations were carried out in 6 months, using New Zealand White dams (n=129), 4 different breed of bucks (New Zealand White, Californian, Burgundy Fawn, Carmagnola Gray: n=40) and their crossbreed.
For each buck, the semen was analyzed considering the following parameters: volume, pH, density, motility and vitality. As far as the reproductive efficiency was concerned, litter size and fertility rate were analyzed.
The analyses showed the following results:
1) about 50% of bucks was not suitable for artificial insemination;
2) no statistically significant differences were found within the genotype for the semen quality;
3) low statistically significant differences ($p<=0.05$) were found among the genotypes;
4) the reproductive efficiency was not affected by genotype;
5) the comparison between litter size and fertility rate showed statistically significant differences between single and heterospermic insemination: in particular, in the Californian breed;
6) the semen quality showed normal positive and negative correlations;
7) the highest correlation between litter size and fertility rate was found in New Zealand White breed;
8) the highest reproductive efficiency values were found in Carmagnola Gray breed: Californian breed looked like the worst, although there were no statistically significant differences.

Introduction

Whenever "reproductive efficiency" (R.E.) is analysed, attention is almost always centred, as also happens with other species, on an analysis of the doe, while the male component is overlooked or undervalued. The ever more widespread use of artificial insemination (A.I.) even with small breeding groups,

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and parallel with this the indiscriminate use of males, very often classified only by morphological characteristics, as well as the habit, increasingly frequent, of using a "semen pool" has prompted the present experimentation; which aims to evaluate the R.E. of different genotypes using single or heterospermic inseminations. (2, 6, 7, 8, 10)
The increasing use of "commercial hybrids" has also highlighted some problems regarding the conservation of animal *germoplasma* and the potentiality of minor breeds, that might otherwise be neglected in so much as judged less efficient productively or reproductively efficient. Regarding this, we have included a breed recently reconstituted by researchers at the University of Turin (Carmagnola Grey) (9, 14, 15) that for certain of its characteristics could prove of interest for breeding, which although not of major importance, concerns several sectors of Italian zootechnics.

Material and Methods

The breeding conditions involved were similar to intensive industrial ones. The principal microclimatic conditions (T°, U.R., ventilation, illumination) are to be considered similar to the range of average values suggested by the references; the rabbits were housed in flat-deck cages. From the bucks initially tested for semen quality and reaction to the artificial vagina (N=40, 10 per breed) the best subjects were selected (N=20, 5 per breed) for the following breeds: New Zealand White (B), Californian (C), Burgundy Fawn (F) and Carmagnola Grey (G); the does, all primiparous at the beginning of the experiment, were New Zealand White (N=129). After a tuning up period of the A.I. techniques, the experiment began, effecting inseminations every fifteen days with single and heterospermic doses every fifteen days. In total 479 inseminations were carried out over 175 days. Within the limits of biological variability it was attempted to maintain as balanced a distribution as possible so as to adequately represent the different genotypes. In the case of the present experiment the reproductive rate used scheduled the first insemination of the does at 11 days after parturition (semi-intensive breeding). The semen collected was analyzed for each buck according to the pre-standardised methods (1, 3, 4, 12); the following parameters were measured: volume (ML), pH (PH), density (DENS), motility (MOT), vitality (VIT). The does were inseminated, always in the morning (between 9 and 11) with the semen of the 4 breeds under test and/or mixing the semen in heterospermic doses (double) composed of the same quantities of semen (50% of each breed) but which were comparable for quali-quantitative characteristics. In particular, the best ejaculate was used (subject to diluition 1:8 with mestruo Tris-Buffer) for the insemination (0.8 ml per dose) with the administration to the doe of 0.2 ml of synthetic hormone (Receptal/Hoechst) at the moment of insemination, to induce ovulation. After insemination the following parameters were evaluated, using ear-tag checking: a) pregnancy diagnosis (PD), b) litter size (LS) and c) litter size/buck genotype (LS/BG). (5, 11) Pearson's correlation coefficients were computed between quali-quantitative characteristics of the ejaculate (DENS, MOT, VIT, ML, PH), the genotype, any vital statistics regarding the LS and R.E. calculated by the relation between the number of births and the number of inseminations (DIV) and by the relation DIVxLS/100 (LS1). Consequently, the eventual statistically significant differences between the various parameters analysed were evaluated, using the Analysis of Variance according to a linear model (GLM) (13). The values indicated, as the analyses also refer to least squares means, apart from the samples, where necessary, have been corrected according to the parity.

Results and Discussion

Tables 1, 2 and 3 indicate the results obtained from the analyses effected. As regards the comparison between the genotypes in the role of LS and DIV, there is no table, as the analyses (GLM) do not show any statistically significant differences in any case among the genotypes; further the situation is the same when litter size is compared according to whether single or heterospermic doses were administered. The reading of the various figures obtained allows us to make three principal observations. The first, regarding the characteristics of the semen; the second, the vital statistics considered, and finally the correlation between these parameters. The does in the test appear to be average, in the sense that only 6.6 live borns were produced for each litter, with a 70% fertility rate. It should be remembered, however, that these values have a very high heterogeneity, underlined by the standard error. Among the different genotypes there was observed a certain superiority both on a productive and a reproductive level, of the Carmagnola Grey, which in some respects is new as concerns comparisons with previous studies. This breed possesses positive values not only in direct crossing with the does, but also when it is present in 50% of the doses of seminal material. However, as already stated, the analysis undertaken is not statistically significant, but it does show this breed in a positive light with respect to the others in the study.
As regards the characteristics of the seminal fluid, it can be noted from the correlations calculated from the quali-quantitative parameters of the ejaculate, for the genotypes analysed, that some parameters such as MOT and VIT, DENS and PH, MOT and PH, VIT and PH, are positively correlated in a statistically significant way in all the breeds, while MOT and ML, VIT and ML, are correlated negatively, but not in a statistically significant way. The correlation between litter size and level of reproductive efficiency (LS and DIV) always

indicates very low figures and is therefore not statistically significant as regards the population, it should be noted that in the case of progenies from B bucks a rather high and statistically significant figure was found. A negative correlation, statistically significant, between the two parameters considered (LS and DIV) is obtained when the progeny of the buck genotype CG are compared. Further there were three other cases of negative correlation, but not significant (F, G, BF). For every genotype there are contradictory results; even if the only two really comparable cases (B and CG) show, however, a variable that should not be overlooked in so much as it is true that the seminal materials underwent identical manipulations, but the reproductive efficiency is negatively correlated to the litter size in the case of kits which result from a dose of heterospermic seminal material, in which the interaction between the nemasperms could have determined a sinergy.
It would seem logical that having used a very homogeneous group of does and above all an analysis adjusted according to litter size, that the size of the litter should correspond with reproductive efficiency. The two variables considered (LS and DIV) have been studied as a possible expression of the interaction of certain quali-quantitative characteristics of the semen. From the correlations calculated only the DENS correlates in a statistically significant way with the size of the litter, but with a negative value, so that for the samples studied it would seem that a diminution of the DENS in the seminal material, increases the number of kits born.

Conclusion

The aim of the study was principally to check the efficiency of A.I. both through the use of the "semen pool" and at the same time evaluate through a comparative test, the productive characteristics of a little known breed like the Carmagnola Grey. Research was based on the study of reproductive efficiency particularly on the role of the buck. To this end the analyses on the buck, on its seminal material and on its litter size, enable us to make the following points:
1) many reproductive bucks are not suited to A.I. either because of negative reaction to the artificial vagina, or the quali-quantitative characteristics of the ejaculate; in this study about 50% of the rabbits were deemed unusable;
2) amongst the different genotypes (B, C, F, G) considered, in relation to the various parameters studied, a high level of heterogenity was found, underlined, also by the statistics produced (standard error); the differences that show up do not reach levels of statistic significance;
3) a high variability is also found among the genetic types studied (B, C, F, G) but which is not however supported with statistic significance;

4) direct comparison concerning litter size (LS) and reproductive efficiency (DIV), between the use of single or heterospermic doses, is not statistically significant, but indicates a certain superiority in size of litter size born from heterospermic doses, as also the reproductive efficiency of the heterospermic doses is superior by 5%. (80% vs 75%);
5) for the same comparison as in point 4, when analysis was made considering the genotypes inside the single and heterospermic subdivisions, there are slight differences in the model as a whole, but these are statistically significant ($p<=0.05$); to be precise, it would seem that the Californian breed is the principal determining influence (C vs B, BC, CG, G, F: statistically significant differences);
6) the correlation values between litter size and the level of reproductive efficiency have indicated the highest figure for B, indicating that, at least in the group that was used in this study, the cross BxB gives the best results for these parameters; on the contrary, the only negative and significant correlation was observed for the CG progeny. This could be explained by the high level of variability in the sample group, and also by the fact that in this genetic composition the Californian breed is present, which is to be considered as the least valid in this study.
The data obtained for the Carmagnola Grey is of particular importance; this breed, which for contingent reasons is very little known, has shown a high rate of reproductive efficiency (DIV) and a high rate of productive efficiency (LS). The statistical comparison with other genetic groups under study, shows it always superior, even if statistical analysis of the whole group does not statistically justify the diversity of this breed in relation to the other three; in fact, it is the marked difference between the Carmagnola Grey and the Californian which provides the only statistically significant comparison. The results obtained from this research lead to consideration of the potential use of the data collected in an operating sector such as that of reproduction in a breeding environment, which necessarily must be compared with the exigencies of selection based upon the improvement of global efficiency. The high rate of rejection of bucks and the similarly wide variability within the group of genotypes, forces greater attention to be paid to the evaluation of R.E., especially when this is estimated through the sole knowledge of the vital statistics of the doe. The evaluation of reproductive efficiency in breeding that does not take the buck into close consideration, can in fact underestimate the reproductive importance of the does. Moreover a more precise and above all global approach is preferable in evaluating this aspect of breeding, which is perhaps most conditions the profitability of zootechnical ventures. We should therefore encourage and promote the circulation of programmes which are easily comprehensible, with low running costs, for the small scale breeder.

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Tab. 1 Correlation coefficients (r) and significative values (p) between vital statistics for genotype.

Genotype		LS - DIV
B	r p	0.54 0.02
C	r p	0.17 0.49
F	r p	-0.25 0.38
G	r p	-0.09 0.80
SINGLE. TOTAL	r p	0.15 0.25

Genotype		LS - DIV
BC	r p	0.27 0.44
BF	r p	-0.37 0.37
BG	r p	0.50 0.20
CF	r p	0.29 0.41
CG	r p	-0.73 0.01
FG	r p	0.19 0.56
HETEROS. TOTAL	r p	0.09 0.50

Legenda:

DIV= births/insem.*100

LS = litter size

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Tab. 2 Least Squares Means and *Standard Error* by genotype.

Geno.	Seminal material param.				
	DENS	MOT	VIT	PH	ML
B	2.96	1.84	3.08	7.52	0.66
	0.70	*1.23*	*1.23*	*0.41*	*0.33*
C	2.96	1.87	3.25	7.37	0.65
	0.54	*1.25*	*1.22*	*0.41*	*0.33*
F	3.12	1.73	2.97	7.45	0.78
	0.48	*1.05*	*1.24*	*0.35*	*0.42*
G	2.77	1.52	2.72	7.33	0.67
	0.53	*0.98*	*1.01*	*0.34*	*0.44*
TOT	2.95	1.76	3.03	7.42	0.68
	0.58	*1.15*	*1.19*	*0.39*	*0.37*

Geno.	Vital Statist.		
	LS	DIV(%)	LS1
B	6.70	73.28	4.91
	0.47	*7.27*	
C	5.46	71.74	3.92
	0.44	*6.85*	
F	6.70	76.90	5.15
	0.50	*7.83*	
G	7.86	77.99	6.13
	0.59	*9.20*	
SING. TOTAL	6.56	74.80	4.91
	0.50	*7.79*	
BC	7.65	80.42	6.15
	0.55	*7.34*	
BF	6.18	78.15	4.83
	0.62	*8.34*	
BG	6.79	85.42	5.80
	0.62	*8.17*	
CF	6.02	74.98	4.51
	0.55	*7.43*	
CG	7.42	80.07	5.94
	0.50	*7.34*	
FG	6.33	82.05	5.19
	0.57	*7.03*	
HETE. TOTAL	6.73	79.70	5.36
	0.58	*7.61*	

Legenda: DENS = Density *
MOT = Motility **
VIT = Vitality ***
PH = pH
ML = Volume

B = New Zealand White
C = Californian
F = Burgundy Fawn
G = Carmagnola Grey

LS= Litter Size
DIV= (Births/Insem.)x100
LS1= DIVxLS/100

* = 2 - high density
2 - normal density
3 - low density
4 - oligospermic
5 - aspermic

** = 1 - Forward progression
2 - Circular movement
3 - Rotatory movement

*** = 1 - 75/100% 2 - 50/75%
3 - 25/50% 4 - 0/25%
5 - 0%

Tab. 3 Correlation coefficients (r) and significative values (p) among the quali-quantitative caracteristics of the semen by genotype.

SEMEN CARACT.		B	C	F	G	TOT
DENS - MOT	r	0.13	0.15	0.12	-0.16	0.09
	p	0.35	0.25	0.48	0.32	0.18
DENS - VIT	r	0.17	0.12	-0.04	-0.21	0.07
	p	0.23	0.36	0.80	0.18	0.37
DENS - ML	r	-0.02	0.13	-0.26	0.16	0.04
	p	0.86	0.33	0.13	0.30	0.62
DENS - PH	r	0.21	0.2	-0.29	0.12	0.14
	p	0.14	0.07	0.10	0.47	0.05
MOT - VIT	r	0.89	0.81	0.76	0.84	0.83
	p	0.0001	0.0001	0.0001	0.0001	0.0001
MOT - ML	r	-0.03	-0.02	-0.13	-0.01	-0.05
	p	0.79	0.83	0.47	0.92	0.51
MOT - PH	r	0.65	0.49	0.28	0.03	0.43
	p	0.0001	0.0001	0.0001	0.0001	0.0001
VIT - ML	r	-0.03	-0.007	-0.22	0.02	-0.06
	p	0.80	0.95	0.20	0.89	0.41
VIT - PH	r	0.66	0.41	0.28	0.09	0.41
	p	0.0001	0.001	0.10	0.56	0.0001
ML - PH	r	0.16	0.07	-0.13	-0.12	0.009
	p	0.27	0.62	0.45	0.44	0.89