DESCRIPTIVE ANALYSIS OF RABBIT SEXUAL RECEPTIVITY AND ITS SOURCES OF VARIATION

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ABSTRACT

This study aimed at evaluating on a large scale, the variability between rabbit does of estrus behavior, and at identifying factors influencing this behavior in the context of a selection experiment. The experiment spanned two generations (G0 and G1) with 2 batches at each generation (B1 and B2). The founder generation (F=G0) was made of 140 rabbit does and the G1 generation was made of 2 lines with 70 does each: a low (L) and a high (H) receptivity line. Rabbit does were tested for expression of lordosis behavior in the presence of a buck during 18 successive tests (3 tests/week). On the basis of 4716 receptivity tests from 275 females, the average receptivity was 56.6% and 18.2% of does expressed a low receptivity (<34 %), 50.7 % a medium one and 33.1 % a high one (>66 %). This result confirms the high variability of sexual receptivity of non-lactating rabbit does maintained without any biostimulation or hormonal treatment. The contribution of females to the total variance was 20.0 % whereas only 1.2 % for bucks. The percentage of receptive does was not significantly different between generations (57.5 *vs* 56.5% respectively for G0 and G1) and the line within generation (F(G0): 57.5, L(G1): 57.7, H(G1): 55.4%). This result indicates the lack of response to selection. In contrast, the average receptivity was significantly higher in B1 than in B2 (61.5 *vs* 52.5%). Two hypotheses (season effect or buck tiredness) were discussed. Differences between lines in the pattern of change in receptivity could have a genetic origin. An effect of the test operator was evidenced. The occurrence of pseudo-pregnancy during the tests as a consequence of uncontrolled ovulations could have interfered with receptivity and the tests results. Further studies would be necessary to verify that sexual behavior is not sensitive to a residual effect of previous tests.

Key words: Rabbit, sexual receptivity, estrus behavior, divergent selection

INTRODUCTION

In contrast to most other domestic species, rabbit does do not show sexual cycles with regular heat periods during which ovulation occurs spontaneously. It has long been assumed that the rabbit doe is in permanent estrus. However, it has been demonstrated that does alternate periods of acceptance (estrus) and of refusal of mating (diestrus), whose durations are highly variable between animals (Moret, 1980; Theau-Clément *et al.*, 2011). A female rabbit is defined as 'receptive' when it accepts mating, as indicated by its position of lordosis in the presence of a buck. Economically, sexual receptivity at the moment of insemination highly influences reproductive performance and consequently the productivity. At the physiological level, sexual receptivity is correlated with more pre-ovulatory follicles on rabbit ovaries (Kermabon *et al.*, 1994) and consequently with higher concentration of plasma estradiol (Rebollar *et al.*, 1992).
The objective of this study was to confirm, on a large scale, the high variability between rabbit does of estrus behavior, and identify factors influencing this behavior in the context of a selection experiment on sexual receptivity (Brun *et al.*, 2012).

MATERIALS AND METHODS

Animals and experimental design

The selection experiment used the INRA1777 strain (New-Zealand White breed). Two generations were performed. G0 was the founder generation (line 'F') and a divergent selection procedure gave rise to the high (H) and low (L) receptivity lines in G1.

At each generation, 140 primiparous does were used, distributed into two batches conducted at a 6 week-interval (Figure 1).

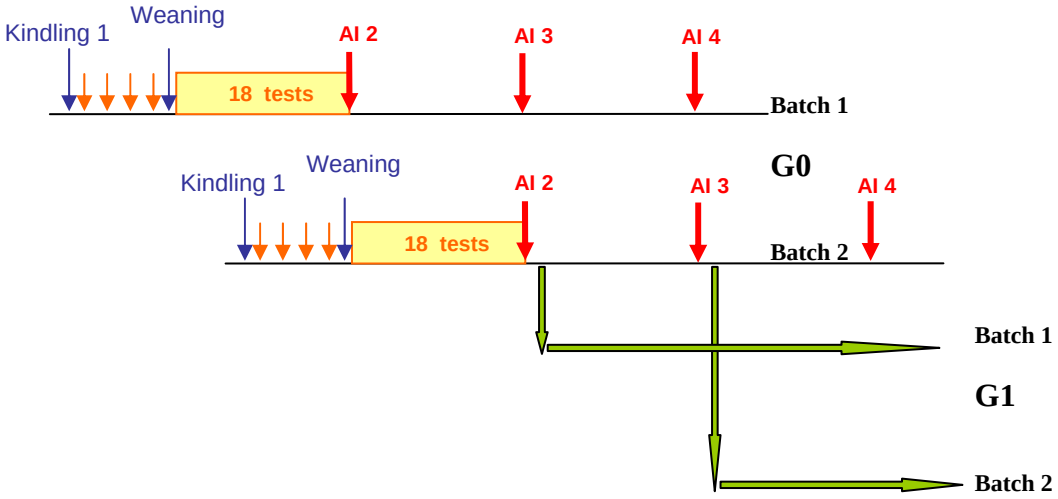

Figure 1. Experimental design (G0: founder generation, G1: first generation)

At each generation, 59 vasectomized INRA2266 bucks were housed in the same room as the females for the receptivity tests. These bucks were geographically spread throughout the room and used to test the two successive batches. After the 1st kindling, the females were tested for their receptivity once a week until weaning. They were then submitted to intensive testing for 6 weeks, with 3 tests per week, leading to a total of 18 tests. The test consisted in observing during 2 min the behavior of the female after it was introduced in a tester buck cage: at the first trial, the female had either a lordosis position (then classified as receptive) or not. If not, a second trial was done with another buck. Neither biostimulations nor hormonal treatment was applied. After the tests period, the does continued their career with a production phase. The breeding values for receptivity were estimated after the tests period (Brun *et al*., 2012). The production of the G1 lines used the top 16 females to form the high line and the bottom 14 females to form the low line. As shown on figure 1, batch 1 of G1 stemmed from AI n° 3 and 2 of the two G0 batches and batch 2 of G1 stemmed from AI n° 4 and 3 of the two G0 batches. In order not to penalize the reproduction of non-receptive females, the does received a subcutaneous injection of 25 IU of eCG (Chronogest - Intervet) two days before AI.

Statistical analysis

The results of the intensive tests period were analyzed. In a first step allowing a descriptive study of the variability between rabbit does, the average receptivity was analysed. In a second one, factors influencing receptivity (0-1 trait) were studied using a mixed linear with the REML method (REstricted Maximum Likelihood) taking into account fixed and random effects. The fixed effects were that of the generation (2 levels: G0, G1), of the batch (2 levels: B1 or B2), of the line within generation (3 levels: F(G0), L(G1) and H(G1) where F =founder population, L and H =low and high receptivity line, respectively), of the test operator (5 levels) and the interaction generation*batch. The random effects were that of the buck within generation and of the female within generation*batch. The procedure proc MIXED was used (SAS, 2001).

RESULTS AND DISCUSSION

Variability of sexual receptivity

Sexual receptivity was studied on 275 rabbit does based on 18 tests. The average receptivity was 56.6%. For G0, 4 females were never receptive and only one for G1. Thirteen and six does were always receptive for G0 and G1, respectively. Three classes of equal amplitude have been defined. The low receptivity class corresponded to 18.2% females, the medium one to 50.7% and the highest one to 33.1%. This result confirms the high variability of sexual receptivity of non-lactating rabbit does maintained without any biostimulation or hormonal treatment (Moret *et al.*, 1980 and Theau-Clément *et al.*, 2012).

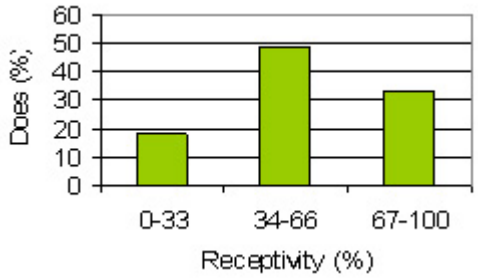

Figure 2. Percentage of does with a low (< 34%), medium or high (> 66 %) sexual receptivity.

The changes in receptivity over time according to generation and batch are represented in figure 3. In G0, the receptivity level considered over the two batches fluctuated between 45 and 67 % excepting the last three tests which evidenced a clear drop. In G1, the changes in receptivity were different in the two batches. In B1, receptivity fluctuated slightly from 50 to 72 % whatever the line. In contrast, the changes depended on the line in B2. For the H line, excluding the first test, the average level of receptivity was lower than in B1 but did not tend to decrease. In opposition, for the L line, there was a general downward trend, generating a lower level of receptivity to that observed in B1.

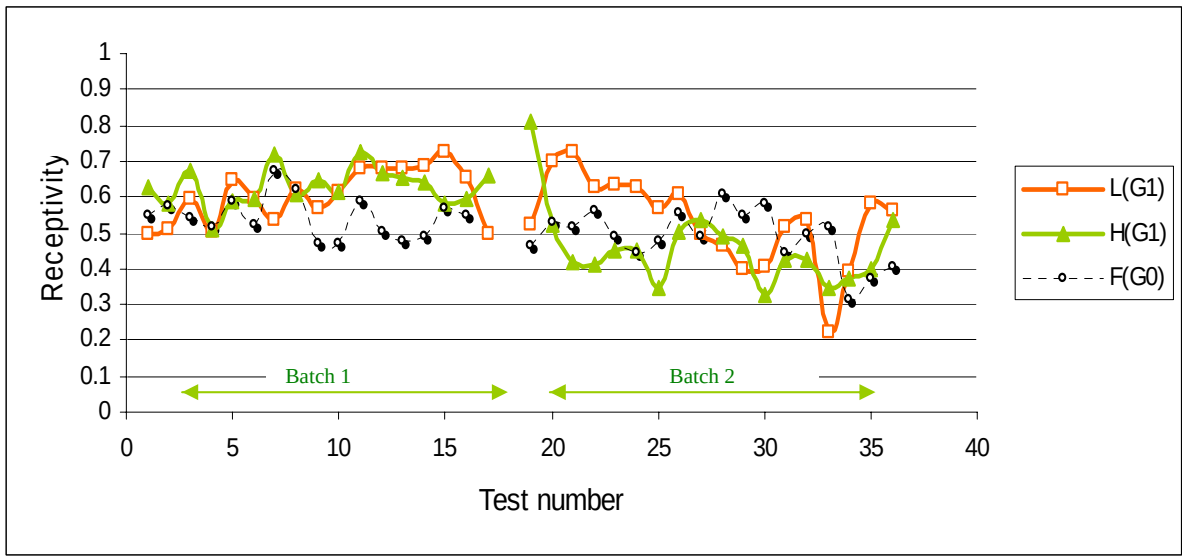

Figure 3. Changes in receptivity according to generation and batch

Some factors influencing sexual receptivity

The results of the variance analysis on 4716 tests are presented in table 1.
Generation effect. The percentage of receptive does was not significantly different according to the generation (57.5 *vs* 56.5% respectively for G0 and G1).
Batch effect. Compared to B2, the average receptivity was significantly higher in B1 (61.5 *vs* 52.5%). Several hypotheses could explain the different receptivity between the two batches, among which a

season effect or a bucks tiredness. On the one hand, the season effect could be discarded since at each generation, the second batch was in more favorable natural photoperiodic conditions compared to B1: in G0, B2 occurred during increasing day length unlike B1; in G1, B1 occurred during decreasing day length, unlike B2. On the other hand, if buck tiredness was decisive, one would observe a similar effect in the three lines, what is not the case. In the F line, the drop of receptivity was observed only at the last three tests. In line L, except during the last tests, a steady decrease was observed in B2 whereas in line H, the drop was observed immediately after the first test of B2. Therefore, the buck tiredness could not be decisive. The difference between lines in the pattern of change in receptivity could have a genetic origin.

Table 1. Estimates of fixed effects and of variance components

	Number	**Receptivity** (%)
Average	*4716*	56.6
Fixed effects		
Generation		NS
0	*2285*	57.5 ± 2.3
1	*2431*	56.5 ± 2.2
Batch		P=0.003
B1	*2163*	61.5 ± 2.3[a]
B2	*2553*	52.5 ± 2.1[b]
Line within generation		NS
F (G0)	*2285*	57.5 ± 2.3
L (G1)	*1231*	57.7 ± 3.0
H (G1)	*1200*	55.4 ± 3.1
Operator		P<0.001
1	*773*	60.7 ± 2.2[a]
2	*1690*	52.7 ± 1.8[b]
3	*1298*	60.6 ± 1.9[a]
4	*580*	57.1 ± 2.3[ab]
5	*375*	54.0 ± 2.9[b]
Generation x batch		NS
G0B1	*1002*	60.4 ± 3.3
G0B2	*1283*	54.7 ± 3.0
G1B1	*1161*	62.6 ± 3.1
G1B2	*1270*	50.5 ± 3.0
Random effects: contribution to total variance (%)		
Females		20.0
Bucks		1.2

NS: P>0.05. Means with different letters are significantly different P<0.05.

Line effect. The percentage of receptive does did not vary according to the line within generation (F: 57.5, L(G1): 57.7, H(G1): 55.4 %). The lack of difference between the H and L lines was quite surprising since their mothers had huge receptivity differences (19.1 % for L line and 91.2 % for H line). This result illustrates the lack of response to selection (Brun *et al*., 2012).
Operator effect. An effect of the person in charge of the tests was evidenced while each of them was implicated at each generation and each batch.
Generation x batch interaction. This effect was not significant: the ranking of the two batches was the same in both generations.
Female and tester buck effects. The contribution of females for the total variance was 20.0 % whereas only 1.2 % for bucks. This demonstrates that in our experimental conditions, the contribution of buck to the expression of does sexual receptivity is very low.

A surprising result (data not presented) was that fertility for inseminations performed the day of the last test of the series was systematically lower (<57%), compared to inseminations performed 6 weeks later (>83%) after a period without any test. A biological interpretation could be that the tests could provoke pseudopregnancies, and consequently a lower receptivity and fertility (Boiti *et al*, 2006). These lower fertility would not have been compensated by eCG, due to its inefficiency in pseudopregnant does as suggested by Theau-Clément *et al.*, 2008. Consequently, in our experimental design, receptivity could be altered by the residual effects of previous tests.

CONCLUSION

This study aimed at confirming on a large scale, the high variability between rabbit does of estrus behavior, and at identifying factors influencing this behavior in the context of a selection experiment. Results confirmed the high variability of sexual receptivity of non-lactating rabbit does maintained without any biostimulation or hormonal treatment: the females accounted for 20 % of the variability. In contrast, the tester bucks accounted for only 1.2 % of the variability. A batch effect (2 successive batches at each generation) and a test operator effect were evidenced. Surprisingly, a lack of selection response on the average of receptivity was observed, but differences between lines in the pattern of change in receptivity could have a genetic origin. Further studies would be necessary to verify that sexual behavior is not sensitive to a residual effect of previous tests able to provoke pseudopregnancies.

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