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Original article

The effect of remating interval and weaning age on the reproductive performance of rabbit does

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Abstract — In this study we investigated the influence of the reproductive system on doe reproductive performance. Two experimental treatments were compared using 36 cages per treatment over an 8-month production period. In the intensive system (IS) rabbit does were mated 4 d after parturition and the litters were weaned at 25 d of age, whereas in the control system (CS) the rabbit does were mated 11 d after parturition and the litters were weaned at 35 d of age. In both systems, the does that failed to mate, conceive or lost their pups were immediately given the opportunity to remate. Initially seventy-two New Zealand × Californian does were assigned to the treatments and used to determine the reproductive traits. Early mating of rabbit does associated with 25-d litter weaning (IS) allowed a shorter parturition interval (39.9 vs. 44.4 d, $P = 0.0001$) and a higher prolificacy (9.07 vs. 8.11 young rabbits born alive per litter, $P = 0.06$), litter size at 21 d (8.24 vs. 7.51, $P = 0.06$) and at weaning (8.21 vs. 7.42, $P = 0.05$) and tended to reduce the number of young rabbits born dead (0.52 vs. 0.94, $P = 0.10$) as compared to the animals in the CS treatment. Consequently, numerical productivity increased from 61.6 to 73.4 young rabbits per cage and year ($P = 0.003$). The intensively bred does had a lower receptivity to the male at the first mating (54 vs. 86.9%, respectively), but 88% of these does accepted mating within 7 d after parturition. Fertility was high, above 80%, in all the matings. The treatments did not affect either the body weight (4301 g as average) or the mortality of the rabbit does (14.6%) and the mortality of the young rabbits during lactation (11.8%). Feed efficiency increased from 0.241 to 0.309 g of young rabbits weaned per g of feed when the remating interval was longer but these results cannot be compared because of the parallel increase in the age and weight of the young rabbits at weaning. This study indicates that, in the conditions of reproductive management used, the numerical productivity can be increased through earlier mating and weaning. However, more information is needed about the effect of this system on young rabbit performance after weaning, and about the possibility of increasing the receptivity of rabbit does at 4 d by using bio-stimulation methods.

reproductive performance / remating interval / early weaning / early mating / doe rabbits

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Résumé — Effet de l'intervalle d'accouplement et de l'âge au sevrage sur les performances de reproduction chez la lapine. Ce travail a eu pour but d'étudier l'influence de deux intervalles d'accouplement (4 ou 11 j après le vêlage) associés à différents âges au sevrage (25 et 35 j, respectivement) sur les performances de reproduction de la lapine. Dans ce but, deux traitements expérimentaux ont été comparés en utilisant 36 cages par traitement pendant une période de production de 8 mois. Initialement, soixante-douze lapines de race Néo-Zélandaise × Californienne ont été réparties dans deux systèmes de reproduction : un système intensif (IS) avec un accouplement à 4 j et un sevrage des portées à 25 j, et un système témoin (CS) avec un accouplement à 11 j et un sevrage des portées à 35 j. Les lapines qui refusèrent le mâle, celles non fécondées ou celles qui avaient perdu leurs lapereaux ont eu la possibilité de s'accoupler de nouveau immédiatement. L'intervalle d'accouplement le plus précoce a été associé à un raccourcissement de l'intervalle entre les vêlages (39,9 vs. 44,4 j, $P = 0,0001$), et à une augmentation de la prolificité (9,07 vs. 8,11 lapereaux nés vivants par portée, $P = 0,06$), de la taille de la portée à 21 j (8,24 vs. 7,51, $P = 0,06$) et au sevrage (8,21 vs. 7,42, $P = 0,05$), ainsi qu'une tendance à réduire le nombre de lapereaux mort-nés (0,52 vs. 0,94, $P = 0,10$). En conséquence, la productivité numérique a été augmentée de 61,6 à 73,4 lapereaux par cage et par année ($P = 0,003$). Les lapines du système IS ont montré une moindre réceptivité au mâle lors du premier accouplement (54 vs. 86,9 %, respectivement), mais 88 % de ces lapines ont toléré l'accouplement dans les 7 j après la mise bas. La fertilité a été élevée dans tous les cas (supérieure à 80 %). Les traitements n'ont pas eu d'effet sur le poids, la mortalité des lapines ou sur la mortalité des lapereaux pendant l'allaitement. Les valeurs moyennes respectives ont été de 4301 g, 14,6 % et 11,8 %. L'efficacité alimentaire (g de lapereau sevré par g d'aliment) a crû de 0,241 à 0,309 avec l'augmentation de l'intervalle d'accouplement, mais ces résultats ne sont pas comparables à l'augmentation parallèle de l'âge et du poids des lapereaux au sevrage. Ce travail montre que, dans les conditions expérimentales mises en oeuvre, la productivité numérique peut être augmentée avec un accouplement et un sevrage précoces. Cependant, des informations supplémentaires sont nécessaires sur les effets de ce système sur les rendements des lapins après le sevrage et sur la possibilité d'augmenter la réceptivité des femelles au mâle à 4 j par des méthodes de bio-stimulation.

performance de reproduction / intervalle d'accouplement / sevrage précoce / accouplement précoce / lapines

1. INTRODUCTION

The nutritional requirements of intensively reared rabbit does are very high because of the overlapping of lactation and pregnancy. In this situation, it is important to adopt the most appropriate reproductive system to improve the energy balance of the lactating does and to maximise their productive potential [23].

At present, the remating interval most commonly adopted by Spanish farms is 11 d after parturition and young rabbits are weaned at 35 d of age. This system is compatible with the rational use of artificial insemination and with the batch management of the farm. With this reproductive system a maximum of 9 parturitions per year and a minimal 42-d interval between parturitions are obtained. However, only around 30% of Spanish farmers use artificial insemination [16].

Several authors [2, 3, 7, 11, 12, 14] have studied over long-term experiments the possibility of increasing the reproductive rate by mating the does the day after parturition and weaning the young rabbits at 28 d of age. Thus, a theoretical 32-d interval between parturitions and a maximum of 11 parturitions per year could be obtained. However, this system is not used in commercial farms because of the nutritional deficit provoked in lactating and concurrently pregnant does and because this system does not fit with a batch management system. Moreover, the short time from weaning to the next parturition (around 4 d) does not allow an adequate recovery of the body reserves of the does [5, 6, 10, 15, 22, 23]. As a consequence, there is a decrease of fertility (by 10%, [12]), milk production (by 10%, [7]), litter weight at weaning (from 4% to 26% [2, 11, 12]) and an increase of young rabbit mortality during lactation (by 53.5%, [12]).

In this context, an earlier weaning of young rabbits could permit to increase the reproduction rate without negative effects on litters [24] and rabbit doe performance [4, 13], because of a reduction in energy requirements [23]. Besides, early weaning would reduce the risk of young rabbit infection through the doe [18]. Furthermore, early mating at 4 d after parturition is also compatible with batch management and the use of artificial insemination. However, a shorter lactation could lead to a higher incidence of mastitis that could be prevented by doe feed restriction at weaning.

The aim of the present investigation was to compare two reproductive systems: intensive vs. control, over a 8-month production period. In the intensive system (IS), the rabbit does were mated 4 d after parturition and the litters were weaned at 25 d of age, whereas in the control system (CS) the rabbit does were mated 11 d after parturition and the litters were weaned at 35 d of age. In both systems, the does that failed to mate, to conceive or lost their pups were immediately given the opportunity to remate.

2. MATERIALS AND METHODS

2.1. Diet

Does and young rabbits until weaning were fed a commercial feed (Cunilactal, Nanta, S.A) containing, on a DM basis, 17.2% CP, 34.2% NDF, 19.0% ADF, 4.8% ADL and 16.1% starch. The diet contained 60 ppm of robenidine and 100 ppm of Zinc bacitracin with no medication in the drinking water. The diet was pelleted (3.5 mm diameter) and the does were given ad libitum access to feed in late pregnancy (from d 28 onwards) and throughout lactation. The rest of the cycle does received a restricted amount (140 to 150 $g \cdot d^{-1}$) of feed.

2.2. Animals

Initially seventy-two New Zealand × Californian does were assigned to the treatments (IS and CS). Thirty-six does were allocated to each treatment after blocking by the number of previous parturitions. Rabbit performance was recorded over an 8-month production cycle and calculated by cage. During the trial, the animals that died or were discarded for different reasons (illness, infertility or low prolificacy) were immediately replaced by nulliparous does. Natural mating was performed and males were included to give a female:male ratio between 8:1 throughout the experiment. Ten days after mating, the pregnancy was tested by abdominal palpation. The does that failed to mate, to conceive or lost their pups were immediately given the opportunity to remate. Reproductive traits (conception rate, parturition interval, prolificacy, pup mortality and replacement rate of the does) were recorded for single rabbit does throughout the experiment and in each were expressed by cage. The feed consumption and weight of the does were recorded between parturition.

2.3. Housing

The animals were housed in flat-deck cages measuring 600 × 500 × 330 mm high. A cycle of 16 h of light and 8 h of dark was used throughout the experiment. Heating and forced ventilation systems allowed the building temperature to be maintained between 18 and 23 ºC throughout the experiment. The animals were handled according to the principles for care of animals in experimentation [19].

2.4. Analytical methods

The chemical analysis of the diet was made using the sequential procedure of Van Soest et al. [21] for NDF (with no amylase pre-treatment), ADF and ADL. The procedures of the AOAC [1] were used for DM (930.15), ash, CP (954.01) and starch (amyloglucosidase-α-amylase method, 996.11).

2.5. Statistical analysis

The cage was considered the experimental unit (n = 36 per treatment). The data were analysed as a completely randomised block design with the reproduction system as the main source of variation, number of previous parturitions as the block effect and initial weight of the rabbit does as a linear covariate by using the General Linear Model (GLM) procedure of SAS [17] (Statistical Analysis Systems Institute Inc., Cary, NC).

3. RESULTS

The effect of the reproductive system on several productive traits is shown in Table I. The does mated 4 d after parturition and weaned at 25 d (IS) showed a shorter interval from parturition to the effective

Table I. The effect of the breeding and weaning system on rabbit does and litter performance.

	System		SEM[1]	*P*
	Intensive[2]	Control[3]		
Parturition-effective mating interval (d)	7.75	12.2	0.63	0.0001
Parturition interval (d)	39.9	44.2	0.64	0.0001
Average doe weight (g)	4298	4304	70.4	NS[4]
Daily feed intake of does+young rabbits (g)	357	460	11.1	0.0001
Replacement rate (% per doe and year)	62.5	37.5	11.8	NS
Mortality (%)	16.7	12.5	7.50	NS
Does eliminated[5] (%)	45.8	25.0	10.6	NS
Numerical productivity (no. weaned kits per cage per year)	73.4	61.6	2.39	0.003
Feed efficiency (g young rabbits weaned per g feed)	0.241	0.309	0.008	0.0001
Number of litters	102	113		
Number of kits born alive per litter	9.07	8.11	0.35	0.06
Number of kits born dead per litter	0.52	0.94	0.18	0.10
Litter size at 21 d	8.24	7.51	0.27	0.06
Litter size at weaning	8.21	7.42	0.28	0.05
Litter weight at 21 d (g)	2871	2773	93.5	NS
Litter weight at weaning (g)	3810	6485	166	0.0001

[1] SEM: standard error of means (n = 36 cages).
[2] Intensive system: theoretical remating interval: 4 d, and weaning age of kits: 25 d.
[3] Control system: theoretical remating interval: 11 d, and weaning age of kits: 35 d.
[4] NS: Non significant ($P > 0.10$).
[5] Low productivity or disease.

Table II. Effect of treatments on reproductive traits of rabbit does in the first mating after parturition.

Theoretical remating interval (d)	Effective remating interval (d)	Receptivity[1] (%)	Fertility[2] (%)	Prolificacy[3]
4	4	54.0	83.3	8.44 ± 0.39[4]
	4–7	34.0	94.1	9.31 ± 0.44
	7–10	6.0	100	9.33 ± 0.71
	10–15	6.0	100	10.83 ± 0.70
11	11	86.9	96.0	8.20 ± 0.30
	11–15	6.90	99.7	7.33 ± 1.38
	15–20	6.10	100	8.86 ± 0.70

[1] Proportion of accepted matings with respect to the total attempts of mating (n = 100 and 115 matings for theoretical remating intervals of 4 and 11 d, respectively).
[2] Proportion of pregnant with respect to total effective matings.
[3] Number of kits born alive.
[4] Standard error of the mean.

mating (by 4.45 d, $P = 0.0001$) and between parturitions (by 4.3 d, $P = 0.0001$) than the does mated 11 d after parturition and weaned at 35 d (CS).

The treatments did not affect either the body weight of the rabbit does or the mortality of the kits during lactation, which averaged 4301 g and 11.8%, respectively. Instead, a shorter parturition-mating period tended to increase prolificacy (by 11.8%, $P = 0.06$), litter size at 21 d (9.7%, $P = 0.06$) and litter size at weaning (10.6%, $P = 0.05$) and to reduce the number of young rabbits born dead (by 45%, $P = 0.10$). Consequently, the increase of numerical productivity (weaned rabbits per cage and year) in the IS with respect to the CS group (by 19.1%, $P = 0.003$) was higher than expected from the shortened parturition interval. Neither mortality nor the replacement rate of the rabbit does were affected ($P > 0.10$) by the treatments, although a non-significant increase of the does replacement was observed in the does of the IS group because of low productivity or disease.

Litter weight at weaning, feed intake of does+young rabbits and feed efficiency increased with the remating interval, but these variables cannot be compared because of the parallel increase in the age of weaning.

The initial weight of the rabbit does and number of previous parturitions did not influence any of the traits studied.

The effect of treatments on receptivity, conception rate and prolificacy in the first mating after parturition is shown in Table II. Receptivity at the first attempt to mate the does was lower in the IS with respect to the CS group (54 vs. 86.9%, respectively). However, 88% of the does from the IS group accepted mating within 7 d after parturition. Fertility was high, above 80%, in all the matings. Prolificacy of the IS does mated at 4 d and those of the CS does mated at 11 d were not different (8.31 kits as average, $P = 0.63$). No incidence of mastitis was detected in the does from the IS or CS groups.

4. DISCUSSION

Previous results indicate that the intensification of reproduction has little effect on does productivity, because of a parallel decrease of fertility [12] and body reserves of rabbit does [5, 6, 10, 15, 22, 23]. The results of this study show that a combination of early mating with early weaning (IS), allowing a 10-d period from weaning to the next parturition, permitted rabbit does to maintain body weight through an 8-month experimental period. However, since no chemical analysis of body reserves were done, it is not possible to state if the chemical composition of body reserves changed during the trial. In these conditions, the intensive system allowed a shorter parturition interval (by 10%) and a higher prolificacy (by 11.8%). Consequently, numerical productivity increased by 19.1%.

The trend for a higher prolificacy with an intensification of the reproduction system has not been reported previously. In fact, in this study, the prolificacy of rabbit does with an actual remating interval of 4 and 11 d in the intensive and control systems, respectively, were not different ($P = 0.63$). However, an average prolificacy of IS does mated from day 4 onwards tended ($P = 0.06$) to increase with respect to those mated at day 4. A greater percentage of the IS does delayed their mating (46%) compared to the CS does (13.1%), which implied that the resting period was almost double for the first group and overlapping between lactation and gestation was reduced. This result might explain the differences in prolificacy among systems as observed previously by Méndez et al. [12]. The main problem to establish an intensive system like the one proposed in this work is the low receptivity of does 4 d after parturition, especially in those farms where artificial insemination is performed. The bio-stimulation of does before mating could increase the percentage of receptivity in the intensive system and make it more attractive in farms that use artificial insemination [20].

Feed efficiency, measured as g of young rabbits weaned per g feed, was lower in the intensive system of breeding. However, it must be taken into account that the results are not directly comparable, because of the difference in weaning age between systems. More information is needed about this point also considering the rest of the fattening period.

Furthermore, the feasibility of early weaning should be assessed before making conclusive recommendations about the optimal reproductive system. Recent studies [8, 9, 24] point out that weaning at 25 d might be possible with no adverse effects on young rabbit performance. Growth rate and mortality observed in the 2-weeks after the weaning period (from 25 to 39 d of age) are variable and depend on the type of diet. Early weaned rabbits showed a limited digestive capacity, but the use of highly digestible diets allowed high levels of DM intake ($> 70\ g{\cdot}d^{-1}$), high growth rates ($> 40\ g{\cdot}d^{-1}$) and low mortality ($< 5\%$) [8, 9, 24].

The results of this study indicate that, in the conditions of reproductive management used, numerical productivity can be increased through earlier mating and weaning. However more information is needed about the effect of this system on young rabbit performance after weaning.

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