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EFFECT OF LIGHTING SCHEDULE ON PRODUCTION OF RABBIT DOES

Gerencsér Zs.[*], Matics Zs.[†], Nagy I.[*], Szendrő Zs.[*]

[*] Kaposvár University, Guba S. str. 40, H-7400 Kaposvár, Hungary.
[†] HAS - ORG Research Group of Animal Breeding and Hygiene, Guba S. str. 40, H-7400 Kaposvár, Hungary.

Abstract: The aim of the experiment was to analyse the effects of the lighting schedule on the rabbit does' production. The does were randomly housed in 2 rooms at the age of 11 wk. In the 1st room, a continuous 16 h light period was applied (8:00-24:00) (16L:8D, control group; n=60 does, 239 parturitions). In the 2nd room, an 8 h light period was used (8:00-16:00) which was extended by an additional 1 h light period in the middle of the 16 h long dark period (23:00-24:00) 8 d prior to insemination (8L:7D:1L:8D, treated group; n=59 does, 223 parturitions). The experiment was finished after 5 reproductive cycles. Significant differences (P<0.05) were obtained for body weight of the does (higher in treated group), litter size (control and treated groups: total born, 9.23 and 8.69; born alive, 8.83 and 8.24, at 35 d, 8.29 and 7.84; respectively), litter weight, individual weight of kits, suckling mortality and for feed consumption between 21 and 35 d of the lactation period. No significant differences were observed for number of inseminations per parturition, feed intake between d 0-21 of lactation, the does' condition at kindling measured by the TOBEC method and doe survival. The annual performance per doe was superior in the control group for number of kits born alive (65.0 and 58.8, P=0.036), number of weaned (at 35 d) kits (58.9 and 53.8, P=0.046) and total weight of the weaned kits (58.2 and 52.7 kg, P=0.049) compared to the treated group. According to the results, the 8 h light period extended by an additional 1 h had no favourable effect on production compared to the continuous 16 h light.

Key Words: lighting schedule; rabbit does; reproductive performance.

INTRODUCTION

On intensive rabbit farms, artificial insemination (AI) generally occurs 11 d *post partum* (dpp) in 42 d reproduction rhythm. During the increasing phase of milk production, the does show less pronounced oestrus because the hormones regulating milk production (prolactin) inhibit those hormones regulating reproduction (Theau-Clément, 2007). In order to achieve favourable receptivity and conception rates at 11 d after kindling, rabbit does are generally treated with PMSG 2-3 d prior to insemination. Depending on the dose and frequency, the PMSG (eCG) treatment of the does may induce antibody production which can negatively influence the kindling rate, while the culling rate can increase in consequence (Castellini, 1996; Theau-Clément, 2007). Moreover, regulation of hormonal treatments can be expected from the EU side (Theau-Clément *et al.*, 2006). For these reasons, researchers and farmers would like to replace the PMSG (eCG) with alternative (biostimulation) methods (Theau-Clément, 2007). Dam-litter separation prior to insemination, changing the nursing method or lighting schedule are some of the methods

Correspondence: Zs. Szendrő, szendro.zsolt@ke.hu. Received *November 2010* - Accepted *October 2011*
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already used in practice. It was proven by several experiments that increasing the light period from 8 to 16 h 7-8 d prior to insemination leads to higher receptivity and kindling rates and occasionally higher litter size (Mirabito *et al.,* 1994; Theau-Clément *et al.,* 1990; Gerencsér *et al.,* 2008).

Our hypothesis was that the 8 h continuous light and the intermittent light (1 h light after 7 h dark) could sum up and make a similar effect to that of increasing the light period from 8 to 16 h. European wild rabbits are mainly active during the night while during the day they rest in their dark holes (Díez *et al.,* 2005). Lighting impulses that influence their reproduction seasonality occur only for short periods at dawn and at dusk. Thus, in this study it was expected that the additional 1 h light period in the middle of the dark period may affect the does' reproductive performance.

The aim of the experiment was to determine the biostimulation effect of the additional 1 h light period after a 7 h long dark period (in the middle of the dark period) compared to the continuous 16 h light.

MATERIALS AND METHODS

The experiment was conducted at the Kaposvár University with Pannon White rabbits. The origin of the bred was described by Szendrő *et al.* (1998).

At 11 wk of age the female rabbits were randomly placed in 2 rooms (n=119, at the beginning of the experiment). The 2 rooms differed only in the lighting schedule. In the 1st room, a continuous 16 h long lighting period was applied (8:00-24:00; 16L:8D; control group, n=60 does, 239 parturitions) from 11 wk of age to the end of the experiment. In the 2nd room, an 8 h long lighting period was used (8:00-16:00) from 11 wk of age which was extended by an additional 1 h light in the middle of the dark period (23:00-24:00) (8L:7D:1L:8D; treated group, n=59 does, 223 parturitions) 8 d prior to each AI. After AI, the lighting schedule was again 8L:16D (Figure 1). In both rooms, 2 further sub-groups were formed: in the 1st sub-group the does and their kits received breeding pellet (10.4 MJ digestible energy, 178 g crude protein and 136 g crude fibre per kg). In the 2nd sub-group, the breeding pellet was replaced by growing pellet (9.7 MJ digestible energy, 160 g crude protein and 172 g crude fibre per kg) at the 21st dpp. The experimental design is shown in Figure 2. Pellet and water was available *ad libitum*.

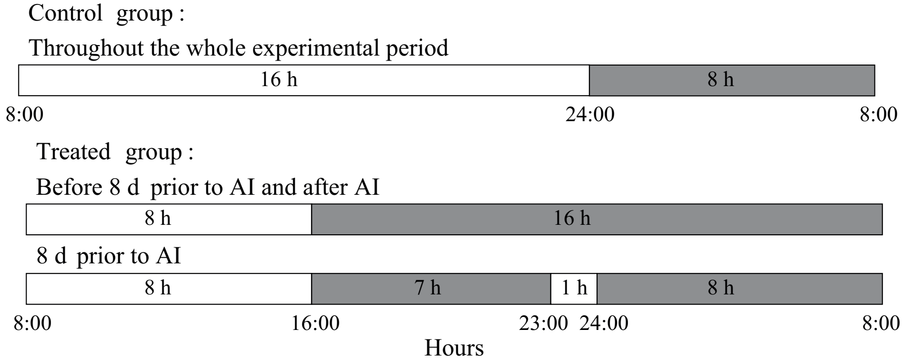

Figure 1: Lighting schedule for the control and treated groups.

The basic area of the breeding cage was 860×385 mm, including the nest box (260×385 mm). In both rooms the temperature could be as high as 28°C during summer while in winter the minimum temperature was 16°C.

The rabbits were 1st inseminated at the age of 16.5 wk, subsequently using a 42-d reproduction rhythm (AI each 42 d, single batch system). AI occurred 11 dpp using diluted semen (of single buck). No hormonal treatment (PMSG/eCG) was applied to any groups to stimulate the receptivity. Does were injected with 1.5 µg GnRH analogue (Ovurelin, Reanal) into their thigh muscle. After birth, the litters were equalised within groups according to the average number of kits born alive (maximum 8 and 10 kits for primiparous and multiparous does, respectively). Does were culled in the event of health problems, weak condition or if they were empty twice consecutively. Dead and culled rabbits were not replaced with young females. The experiment was completed after 5 reproductive cycles.

During the experiment, litter size (total born, alive born and 21 and 35 dpp), body weight of the does and litter weight at parturition, at 21 and 35 dpp were recorded. The body condition of randomly selected rabbit does (n=30) from every group were evaluated by total body electrical conductivity (TOBEC) measurements (E-value) (EM-SCAN Model SA-3203 type). The method was described in detail by Fortun-Lamothe *et al.* (2002). These does were locked out from the nest boxes (the day before measurement) and allowed to nurse their kits immediately prior to the TOBEC measurements so that the milk within the mammary gland could not influence the results. TOBEC measurements of the non-lactating does took place on the same day. At the time of TOBEC measurement, rabbit does were also weighed. Feed consumption was measured during the 1st gestation then between kindling and 21 dpp and between 21 and 35 dpp. In the latter case, the total feed consumption of the doe and her litter was recorded. Rabbits were weaned at 35 dpp.

The productivity index calculation was based on the IRRG recommendation (2005). The numerical productivity (number of live born and weaned rabbits per inseminated doe) and overall

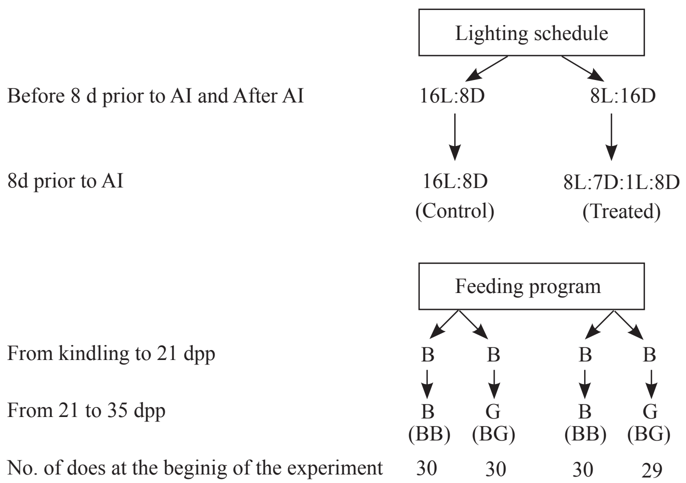

Figure 2: Experimental design, describing both lighting and feeding programmes used.

16L:8D=16 h light and 8 h dark. 8L:16D=8 h light and 16 h dark. 8L:7D:1L:8D=8 h light, 7 h dark, 1 h light, 8 h dark. B=Breeding pellet. G=Growing pellet. dpp: days *post partum*.

productivity (weight of weaned rabbits per inseminated doe) were multiplied by the number of theoretical AI per year (8.69).

The production traits (except for the rabbit does' condition) of the does were evaluated by multifactor ANOVA using the following model:

$$Y_{ijkl} = \mu + A_i + B_j + C_k + (AB)_{ij} + (AC)_{ik} + (BC)_{jk} + e_{ijkl}$$

where:

Y_{ijkl}= observation *l* in level *i* of factor A, level *j* of factor B and level *k* of factor C,
μ= the overall mean,
A_i= the fixed effect of level *i* of factor lighting schedule (*i*=1, 2),
B_j= the fixed effect of level *j* of factor feeding program (*j*=1, 2),
C_k= the random effect of level *k* of factor parity order (*k*=1, …, 5),
$(AB)_{ij}$= the effect of the interaction of level *i* of factor A with level *j* of factor B,
$(AC)_{ik}$= the effect of the interaction of level *i* of factor A with level *k* of factor C,
$(BC)_{jk}$= the effect of the interaction of level *j* of factor B with level *k* of factor C,
e_{ijkl}= random error with mean 0 and variance σ^2.

By evaluating the rabbit does' condition (TOBEC, E-value) the applied model was extended with the body weight of the rabbits, which was considered as a covariate. Mortality was analysed by χ^2-test. All statistical analyses were conducted using the SPSS 10.0 software package.

No significant interaction was observed between the lighting schedules and feeding programmes for any trait, which is why the results of the experiment are published in 2 separate papers. In this paper, the effect of lighting schedule is discussed.

RESULTS AND DISCUSSION

The rabbit does' production is presented in Table 1 by parity order. The effect of parity order on the does' production was in accordance with the literature (Szendrő and Maertens, 2001; Xiccato *et al.*, 2004; Rebollar *et al.*, 2009; Tuma *et al.*, 2010). Concordantly with the findings of other authors, it can be concluded that the production of multiparous does substantially exceeds that of primiparous rabbits. The levels of kindling rate and productions were below average after the second parturition, which can be explained by the negative energy balance in primiparous pregnant and lactating does (Xiccato, 1996). Afterwards the production was balanced until the 5th parity. No significant interaction was detected between parity order and lighting schedule.

Results connected to the effect of the lighting schedule are summarised in Table 2. Based on the results there was no significant difference in the number of inseminations per kindling between the 2 groups. The calculated kindling rates of the control and treated groups were 84.7% and 86.2%, respectively. According to our results, when applying a 1 h additional light period (treated group) no such improvement in kindling rate was detected when the light period was increased from 8 to 16 h (Theau-Clément *et al.,* 1990; Mirabito *et al.,* 1994; Gerencsér *et al.*, 2008). It seems that applying 1 h of additional lighting (7 h after the 8 h long light period) "was not equivalent" to the 16 h light period. It must be taken into account that both groups showed favourable kindling rates, so a large increase could not be expected.

Body weight of the does at kindling, at 21 and at 35 dpp was higher in the treated group than in the control group (*P*<0.05). The higher productivity of does in the control group (litter size and litter weight) may have an effect on body weight. Feed intake between kindling and 21 dpp was not significantly different, so perhaps the does in this group had to mobilise more fat deposits to rear their progeny.

Feed intake is higher in the dark period and lower in the light (Reyne *et al.*, 1978a). According to Reyne *et al.* (1978b), when a 10 h period was increased to 16 h an increased daily feed intake of growing rabbits was observed. Keeping the rabbits in a 24 h long dark period also resulted in increased feed intake (Lebas, 1977). However, no differences were found for the rabbits' condition between the 2 groups based on the TOBEC method. Thus, the higher body weight did not result in a better condition.

Total number of kits born, number of kits born alive and number of weaned kits (at 35 dpp) were higher in the control group compared to the treated rabbits (P=0.015, P=0.006 and P<0.001, repectively). When the light period was increased from 8 to 16 h prior to insemination, Mirabito *et al.* (1994), Maertens and Luzi (1995), and Gerencsér *et al.* (2008) found no difference for litter size compared to the continuous 16 h light period. Thus, as with the lighting schedule when the light period was increased from 8 to 16 h, the 1 h additional light period (treated group) was also unsuccessful.

Table 1: Effect of parity order on productive performance of does.

	Parity order						
	1	2	3	4	5	SE	*P*-value
No. of does at the beginnings	119	117	104	80	40		
AI/kindling	1.18	1.26	1.2	1.10	1.00	0.02	0.002
Body weight of does, g							
at kindling	3907	4137	4269	4281	4244	18	<0.001
21 dpp	4552	4730	4872	4867	4767	18	<0.001
35 dpp	4445	4568	4646	4645	4615	17	<0.001
Litter size							
total	7.75	9.07	9.58	9.49	10.0	0.12	<0.001
alive	7.42	8.76	9.01	9.07	9.31	0.11	<0.001
stillborn	0.33	0.32	0.57	0.41	0.71	0.46	0.079
21 dpp	7.10	8.17	8.71	8.69	8.91	0.06	<0.001
35 dpp	7.04	8.13	8.71	8.47	8.83	0.06	<0.001
Litter weight, g							
21 dpp	2586	3250	3604	3563	3514	24	<0.001
35 dpp	6696	8135	8932	8439	8380	59	<0.001
Individual weight, g							
21 dpp	366	400	412	411	395	3	<0.001
35 dpp	951	1004	1017	983	946	5	<0.001
Mortality of kits, %							
0-21 dpp	4.05	3.08	3.97	3.44	3.36		0.880
21-35 dpp	0.70	0.61	0.00	2.42	1.01		0.077
TOBEC, E-value							
lactating	1643	1846	2131	2146	2088	24	0.070
non-lactating		2253	2246	2235	2181	63	0.305

SE: Standard error. dpp: days *post partum.*

Differences were recorded to the advantage of the control group for litter weight at birth (P=0.048), at 21 d (P=0.006) and at 35 d (P<0.001). However, the results were influenced by the larger litters at birth and by the larger number of rabbits reared by the does in the control group. There is a strong positive correlation between the litter size and litter weight that is supported by the larger individual body weight of the kits at birth and at 21 d of the treated group. In larger litters the available milk per kit is lower, which leads to a decreased individual weight of the kits (Maertens *et al.,* 2006). No differences were found for individual weaning weight (at 35 dpp). From the age of 21 d the kits consume an increasing amount of pellet, so their body weight is less influenced by maternal effects.

Table 2: Effect of lighting schedule on the rabbit does' production.

	Lighting schedule			
	Control	Treated	SE	*P*-value
No. of does at the beginnings	60	59		
No. of total parturitions	239	223		
AI/kindling	1.18	1.16	0.02	0.419
Body weight of does, g				
at kindling	4093	4184	18	0.005
21 dpp	4689	4792	18	0.002
35 dpp	4530	4611	17	0.018
Litter size				
total	9.23	8.69	0.12	0.015
alive	8.83	8.24	0.11	0.006
stillborn	0.40	0.45	0.46	0.570
21 dpp	8.35	7.92	0.06	0.319
35 dpp	8.29	7.84	0.06	<0.001
Litter weight, g				
alive	556	532	6	0.048
21 dpp	3280	3159	29	0.006
35 dpp	8219	7741	69	<0.001
Individual weight of kits, g				
alive	63.7	66.1	0.5	0.008
21 dpp	390	400	2.5	0.034
35 dpp	985	984	5.0	0.681
Mortality of kits, %				
0-21 dpp	3.5	3.9		0.664
21-35 dpp	0.7	0.9		0.777
Feed intake, g/d				
0-21 dpp	413	414	3	0.762
21-35 dpp	689	660	4	0.001
TOBEC, E-value				
No.	115	104		
lactating	1943	1937	24	0.501
No.	28	29		
non-lactating	2287	2177	63	0.835
Doe survival, %	85.0	74.6		0.117
Productivity index				
No. of live born kits/doe/y	65.0	58.8	1.4	0.036
No. of kits at 35 dpp/doe/y	58.9	53.8	1.3	0.046
kit's weight (kg) at 35 dpp/doe/y	58.2	52.7	1.4	0.049

Control group: 16L:8D lighting regime; Treated group: 8L:16D throughout the whole experimental period but 8L:7D:1L:8D eight d before each AI. SE: standard error. dpp: days *post partum.*

No difference was detected in the kits' mortality between the groups during the first 3 wk of lactation and between the 21 and 35 dpp. No significant difference was observed for feed consumption during the 1st parturition (control group: 168 and treated group: 175 g/d, P=0.242) and during the first 3 wk of lactation. From the 21 dpp until weaning, the control group consumed more pellet than does in the treated group (P=0.001). This finding is probably associated with litter size because at 35 dpp more kits per litter were found in the control group and besides the feed consumption of the does the kits also contributed to the total feed consumption.

The survival of control does was slightly higher compared to that of the other group, although the differences were not significant.

The total number of kits born per 100 inseminations (782 and 749) and the number of kits reared until weaning (703 and 679), are more suitable parameters for practical rabbit production, and were 4.4% and 3.5% higher for the control group kept using a conventional lighting schedule. Compared to the treated rabbits, the annual performance per doe was superior in the control group for number of kits born alive (by 10.5%, P<0.05), number of weaned (at 35 dpp) kits (by 9.5%, P<0.05) and total weight of the weaned kits (by 10.4%, P<0.05), respectively (Table 2). Thus, it can be concluded that for the parameters with the highest economic interest the treated group was not superior.

The 8+1L lighting schedule (treated group) was disadvantageous only in economical terms. From the animal welfare viewpoint, the 1 h lighting in the middle of the dark period cannot cause any harmful effects for animals active during the night.

CONCLUSIONS

According to our results, the additional one hour in a 8L:16D light period (treated group) had no positive effect on the reproductive performance compared to continuous 16 h light. This method should not be posited for biostimulation.

Still, this area may be worth further research. It would be interesting to investigate its possible effects under unfavourable environmental conditions where the kindling rate is lower than that of this study. Moreover, a longer additional light period could also be tested.

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