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THE EFFECT OF 10, 12, AND 14 HOUR CONTINUOUS AND INTERMITTENT PHOTOPERIODS ON THE REPRODUCTIVE PERFORMANCE OF FEMALE RABBITS

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Abstract

Thirty-six Rex rabbit does were equally divided into continuous and intermittent photoperiod regimens to test photoperiodic effects on the reproductive performance of the rabbit over a ten month trial. Each treatment was placed in one of six identical, environmentally controlled rooms under the following lighting schedules: (1) 10L:14D; (2) 12L:12D; (3) 14L:10D; (4) 1L:3.5D:1L:3.5D:1L:14D; (5) 1L:4.5D:1L:4.5D:1L:12D; (6) 1L:5.5D:1L:5.5D:1L:10D. These simulated continuous and intermittent light-days of 10, 12 and 14-hr respectively. Intermittent lighting resulted in more (P<.05) kits per doe than continuous (20 v. 17). Conception rate ((64.7 v.55.6), litters per doe (2.9 v. 2.6) and litter size (6.7 v. 6.4) were statistically similar but numerically in favor of intermittent lighting. Among the continuous treatments, does under 14 h of light were consistently superior to those of 10 and 12 h in all reproductive parameters and significantly (P<.05) so in kits per doe (25, 13 and 15) and litter size (7.7, 5.6, and 6.0). The conception rate (65 v. 46.7%) of does under 14 h of continuous light was significantly greater than that of does subjected to 10 h of light. Among the intermittent treatments, a similar trend did not exist, 10 and 12 h of intermittent light were as effective or statistically superior to 14 h in doe performance for every reproductive parameter. Intermittent lighting stimulated significantly (P<.05) greater kit weight gains than continuous at both twenty (13.0 v. 11.0 g/d) and thirty (20.2 v. 16.9 g/d) days of age. The more rapidly growing intermittent litters also consumed more (P<.05) feed (65.6 v. 56.7 g) but at a similar rate of efficiency (3.25 v. 3.3). Likely due to their nocturnal behavior, rabbits consistently consumed more feed on intermittent treatments that gave only 3 h of total light as compared to the corresponding continuous treatments with 10, 12 and 14 h of light respectively. It was concluded that Rex rabbits need at least 14 h of continuous light to meet their reproductive potential and that intermittent lighting schedules of 10, 12 and 14 h are equally as effective as 14 h of continuous light in fostering doe reproduction. Feed consumption appears to be inversely related to total hours of light.

Introduction

For many species light is a "zeitgeber," an environmental cue, that entrains the circadian rhythms associated with reproduction. These animals appear to have an endogenous circadian rhythm of "photosensitivity". For long-day breeders such as the vole (Grocock and Clarke, 1974) , chicken (Wilson, 1982) and turkey (Slaugh et al., 1990) long days stimulate animal reproduction because light is present during the "photosensitive period" of the circadian rhythm. On the other hand, for short-day breeders such as sheep (Lincoln and Short, 1980) light is absent during that period.

Figure 1. Experimental photoperiods

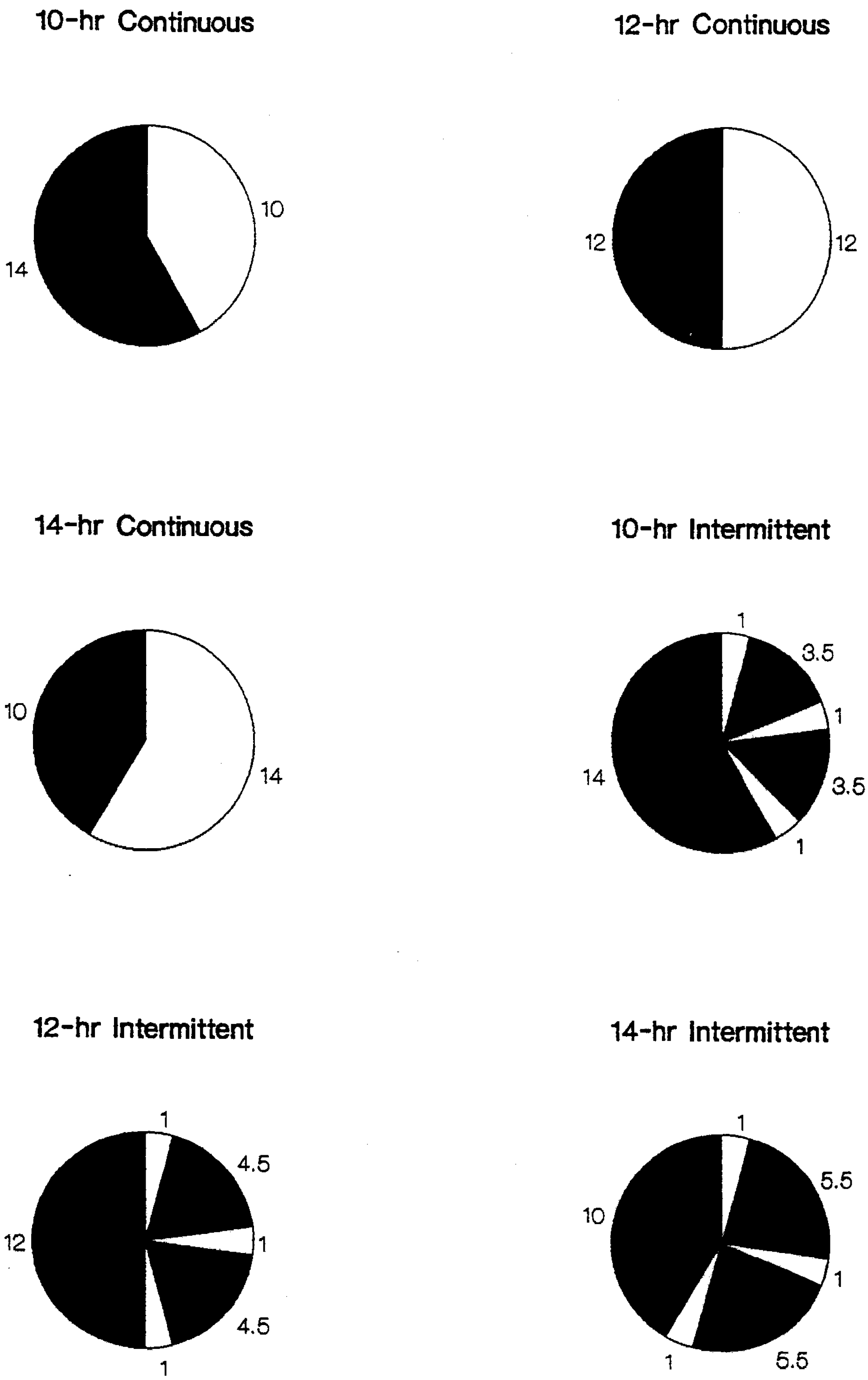

Table 1. Experimental ration.

Ingredients	Amount (%)
Wheat, ground	26.3
Soybean meal (48%)	16.2
Sun cured alfalfa	50
Molasses	3
Bentonite	2
Dicalcium phosphate	1.1
Vitamin-mineral premix	1
Salt	0.4
Total	100
Calculated Analysis	
Crude protein (%)	18
Metabolizable energy (kcal/kg)	2,355
Crude fiber (%)	14
Fat (%)	2
Calcium (%)	1.1
Phosphorus (%)	0.5
Methionine-cystine (%)	0.8

The vitamin and trace mineral mix contained the following per kg of feed: Vitamin A, 12,440 IU; vitamin D, 2500IU; vitamin E, 2.6 mg; vitamin B_{12}, .03 mg; riboflavin, 4.13 mg; niacin, 24.75 mg; d-pantothenic acid, 5.78 mg; folic acid, .41 mg; MSBC, 2.48 mg; pyridoxine, .83 mg; choline chloride, 500 mg; manganese, 107 mg; zinc, 103 mg; iron, 36 mg; iodine, 2.25 mg; cobalt, .9 mg; sulfur, 220 mg; potassium, 180 mg; magnesium, 650 mg.

Results and Discussion

When considering continuous lighting alone, does maintained under the longest photoperiod (14-h) were consistently superior to does of 10 and 12 h in all reproductive parameters (Table 2 and Figure 2) and significantly ($P<.05$) so for kits per doe (25, 15, and 13) and litter size (7.7, 6.0 and 5.6). Which would lead one to speculate that the photosensitive period of the doe, if one exists, is at least 14 h after dawn and possibly longer. Interestingly, however, the same trend did not hold true for does kept under intermittent lighting. Ten and 12 h of intermittent light were equally as effective or statistically superior to 14 h in stimulating each parameter. Intermittent light was consistently more effective than continuous light in photostimulating does.

There are various clues that light is an important environmental cue for rabbit reproduction as well. Kamwanja and Hauser (1983) illustrated that photoperiod influences the onset of puberty. Females reared under the short light-day of 6L:18D required 17 more days to reach puberty than those raised under the long-day of 18L:6D. Wild rabbits have an annual cycle of reproduction that is seemingly stimulated by longer days (Boyd, 1985). Domestic does suffer from a notorious decline in fertility during the winter months (short days) as well. Lebas et al., (1986) observed that does were far more opposed to mating under an 8-h day as compared to a long, 16-h day. It has been observed in central Europe that only 15% of does allow mating in non-heated sheds without a lighting program between the months of October through January as compared to 80% during the period of April to June (Schlolaut, 1985). Long term experiments comparing doe exposure in artificially lighted, long days to natural-light days with varying day lengths tend to favor the long artificial day. This was illustrated by Harris et al., (1982) who compared the reproduction of does under natural versus artificial lighting (16L:8D) for one year and found significantly shorter litter intervals (47 v. 43 days) and slightly more progeny (37.6 v. 34.7) in favor of the 16-h light day. When comparing a 14-h day to natural day light, Jensen and Tuxen (1981) found higher conception rates (93 v. 83%) from the first mating and shorter litter intervals (67 v. 97 days) for females exposed to 14-h light.

This research was conducted to further explore the presence of a circadian photosensitive period of reproduction for rabbits. It was designed to observe the effect of a range of photoperiods (10, 12 and 14 h) both continuous and intermittent on the reproductive efficiency of the Rex doe.

Materials and Methods

For a 10 month trial, thirty six virgin Rex does were equally divided into six identical environmentally controlled rooms. Each room was placed under a different photoperiod as follows: (1) 10L:14D; (2) 12L:12D; (3) 14L:10D; (4) 1L:3.5D:1L:3.5D:1L:14D; (5) 1L:4.5D:1L:4.5D:1L:12D; and (6) 1L:5.5D:1L:5.5D:1L:10D (Figure 1). These schedules simulated continuous and intermittent photoperiods of 10, 12 and 14 hours. Gestating does were fed 150 grams/day of pelleted feed (Table 1) and lactating does *ad libitum*. Water was available *ad libitum*. Room temperature and light intensity were 18° C and 100 lux, respectively.

Following a three-week adaptation period, does were bred artificially with 0.5 ml of pooled semen diluted (1:10) with 0.9% saline solution using the technique of Heidbrink et al., (1980). Males contributing to the semen pool were housed under 14 h of continuous light. Does were induced to ovulate by the intramuscular injection into hind leg of 0.2 ml of Cystorelin (10 mcg GnRH), a source of bovine GnRH. When a female failed to conceive, she was rebred by artificial insemination 28 days after the initial insemination. Does were rebred 15 days following kindling. Following kindling the does and their progeny were weighed at 20 and 30 days of age.

Due to high variability of litter size (1 to 14), only litters with 5, 6 or 7 kits were considered for the statistical analysis. Data were analyzed by analysis of variance and differences among means were determined by Duncan's New Multiple Range test (Ott, 1988).

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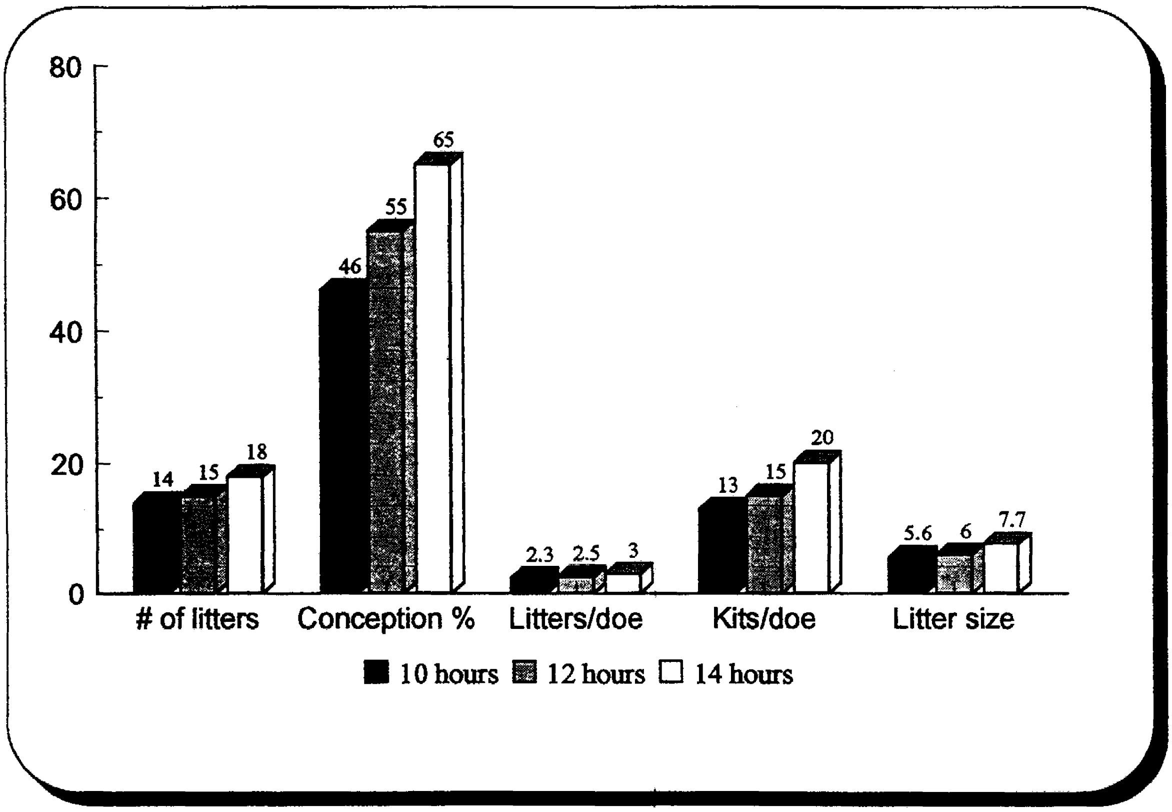
Table 2. Effect of photoperiod on the reproductive parameters[1] of Rex rabbits.

Treatment	*# of Litters*	*Conception rate (%)*	*Litter/doe*	*Kits/doe*	*Litter size*
Continuous	46	55.6	2.6	17^{b}	6.4
Intermittent	52	64.7	2.9	20^{a}	6.7
10-h cont.	14	47.7^{c}	2.3	13^{b}	5.6^{b}
12-h cont.	15	55.0^{bc}	2.5	15^{b}	6.0^{b}
14-h cont.	18	65.0^{ab}	3	23^{a}	7.7^{a}
10-h int.	19	65.0^{ab}	3.2	20^{ab}	6.2^{b}
12-h int.	20	76.5^{ab}	3.3	25^{a}	7.4^{a}
14-h int.	14	63.3^{bc}	2.3	15^{b}	6.6^{ab}
SEM		5.6	0.5	0.6	0.41

Means in the same column followed by different letters are significantly different (P<.05)

Figure 2. Effect of phtoperiod length on rabbit reproductive performance



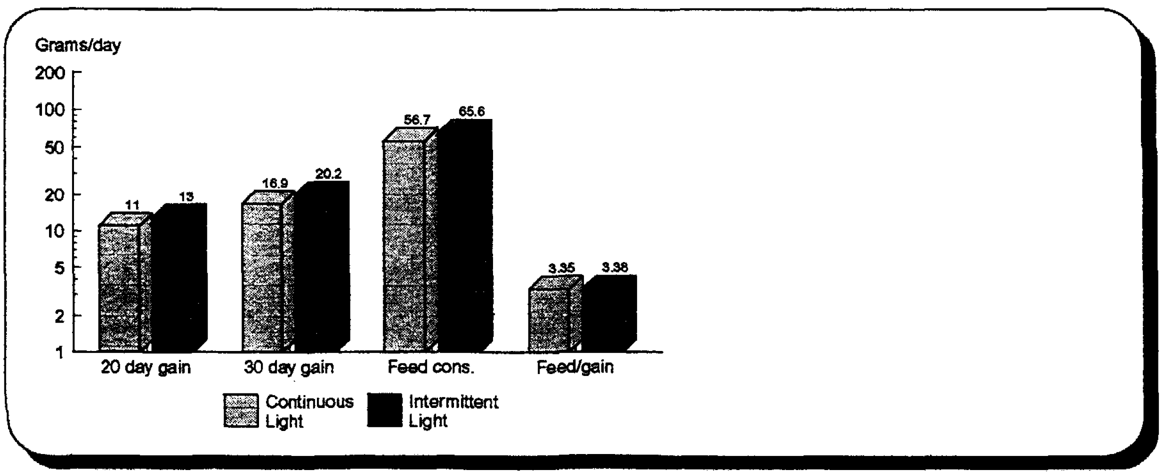
There seemed to be a direct relationship between the hours of darkness and the level of feed consumption and the resulting rates of growth. Under intermittent lighting where the does received only three total hours of light daily, feed consumption (65.6 v. 56.7 g/d) was greater ($P<.05$) than that resulting with continuous light (Table 3). Conceivably, the rabbit, whose feed consumption rises as dusk approaches, views the transition from each intermittent light period as a stimulus on feed consumption similar to dusk. As feed consumption increased under limited light so did the growth rate ($P<.05$) at 20 days (13.0 v. 11.0 g/d) and at 30 days (20.2 v. 16.9 g/d). Because the nourishment of the 20 day growth arises soley from lactation, one must assume that the higher feed consumption is leading to an increase in the level of lactation. Of the continuous treatments, the 10 h, which provided the least amount of light, appeared to have the most positive influence on feed consumption and growth. There were no significant differences or trends among the intermittent treatments.

Table 3. Effect of photoperiod on feed consumption and growth of rabbit kits

Treatment	*Daily gain to 20 days (g/day)*	*Daily gain to 30 days (g/day)*	*Feed consumption 30 days (g/day)*	*30 day feed efficiency*
Continuous	11.0^{b}	16.9^{b}	56.7^{b}	3.35
Intermittent	13.0^{a}	20.2^{a}	65.6^{a}	3.38
SEM	0.55	0.71	1.8	
10-h continuous	12.5^{abc}	17.5^{ab}	61.8^{ab}	3.53
12-h continuous	10.0^{c}	15.2^{b}	53.1^{b}	3.26
14-h continuous	10.6^{bc}	17.1^{ab}	55.3^{b}	3.23
10-h intermittent	12.6^{ab}	20.6^{a}	60.7^{ab}	3.35
12-h intermittent	13.5^{a}	20.1^{a}	67.6^{a}	3.36
14-h intermittent	12.8^{ab}	19.9^{a}	68.5^{a}	3.44
SEM	0.79	0.85	2.4	0.1

Means followed by different letters are significantly different ($P<.05$)

Figure 3. Continuous and intermittent light on feed consumption and growth.



In conclusion, 14 h of continuous light was more photostimulatory for doe reproduction than 12 h or 10 h which might indicate a photosensitive period of 14-h or more. Intermittent photoperiods of 10 h, 12 h and 14 h were not different in their effect on doe performance but equally or more effective than continuous light. Intermittent lighting appears to stimulate feed consumption which in turn accelerates growth rate.

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