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Review article

Effect of lighting on rabbits and its role in rabbit production: A review

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ABSTRACT

Life is based on sunlight. Light is important for the crepuscular or nocturnal animal species such as wild or domesticated rabbits. They are able to see well at night; however their colour vision is limited. Rabbits are exposed to a periodic light and dark environment which generates a 24 h (circadian) rhythm of almost every function of the body. When rabbits lived in continuous light or dark the daily rhythms were a little longer or shorter than 24 h, respectively. The daily activity of European wild rabbits (*Oryctolagus cuniculus*) depends on the season (the time of sunrise and sunset), and that of farmed rabbits on the times that the lights are switched off and on. Strong seasonal effects can be found in reproduction and moulting. In farms, the seasonal effects are limited when 16 h lighting is applied year around. Change of 8 h light to 16 h light eight days before insemination is effective to increase the receptivity and kindling rate. Maturation of Rex rabbit fur can be accelerated and its quality can be improved changing the photoperiod from a long to a short daily lighting period. The wool production of Angora rabbits can be increased by shortening the light period or by melatonin treatment. Light schedules are applied for different purposes on rabbit farms. Further research on the effects of light intensity, colour and LED lighting are needed.

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Contents

1. Introduction

On 20 December 2013 at its 68th Session, the UN General Assembly proclaimed 2015 as the International Year of Light and Light-based Technologies (IYL, 2015). Since life is based on

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sunlight, crop and animal production have a very close connection with natural and artificial light. Because a large majority of commercially produced rabbits are housed in buildings with artificial light, the timing, colour and intensity are very important factors. We have summarised the research results on the effects of light, both natural and artificial, on rabbits and suggested areas where further research is needed.

Changing the duration of the daily lighting period through the seasons affects the behaviour, physiological parameters, reproductive and some other productive performance of rabbits. The reproduction of European wild rabbits (*Oryctolagus cuniculus*) is under control of the seasons and reproduction is carried out such that the pregnant and lactating does and their progeny can receive sufficient feed (Boyd and Bray, 1989). It probably is the result of evolution that regulation of the reproductive period and growth of vegetation are controlled by the same signal (change of the daylight length). Because of this, the natural photoperiod and the lighting schedules in rabbit houses may have significant roles in reproduction and other traits. Questions regarding the effects of colour and intensity still remain.

2. Vision of rabbits

The rabbit's eye structure, vision, colour and light detection are in many ways different from other mammals and humans. Three types of sensory cells can be found in the rabbit retina receptors: rods, S (short-wave) cones and M (middle-wave)/L (long-wave) cones. The order of formation is: rods→S cones→M/L cones (Yokoyama and Radlwimmer, 1999). The rabbit is a rod dominant animal: approximately 5% of the photoreceptors in the retina are cones. M cones outnumber the S cones by almost an order of magnitude with the ratio of 1:10 (Juliusson et al., 1994). It is estimated that for rabbits 6–7 times less light is needed for sharp vision than humans, because the rabbit is a nocturnal/crepuscular species with peaks of activity at sunset and sunrise. The visual streak of the rabbit retina is a horizontal band lying below the optic nerve head, with many green cones and fewer blue cones in the middle horizontal band of the eye. The blue streak, an area with many blue but no green cones, is found in the lowermost crescent of the rabbit retina (Juliusson et al., 1994). The visual streak takes part in horizon imaging (panoramic vision), and is primarily seen in animals which have to move around in open areas, and orient in wide ranges. The colour vision of rabbits, as nocturnal species, is limited. They have dichromatic vision with a blue (425 nm) and green (520 nm) sensitive spectral peak (Nuboer, 1986).

3. Circadian rhythm, biological clock

European wild rabbits are active at night, especially at dusk and dawn, and they live and sleep during the daytime in the warren (Villafuerte et al., 1993). Díez et al. (2005) hardly observed any movement between 10:00 and 16:00 h, the peaks of activity were at 20:00 and 08:00 h but it was lower between 03:00 and 06:00 h. Drees (1988) showed how the duration of daily activities varied from month to month, depending on the times of sunset and sunrise.

3.1. Times of feed and water consumption and hard and soft faeces excretion

Several years ago investigations were performed on wild and domesticated rabbits to determine how the light and dark periods influenced their behaviour under undisturbed laboratory conditions. Prud'hon et al. (1975) observed the consumption of solid feed and water of rabbits at 6 and 18 weeks of age. The consumption increased before the dark period and stayed at a high level till the beginning of light, and it was the lowest between 11:00 and 16:00 h, especially in younger animals. Similar observations were found with lactating does by Reyne et al. (1977) when free nursing was applied. However, in the case of controlled nursing, the solid feed and water consumption sharply increased at the time of nursing in the morning.

Under farm condition similar results were achieved. Bellier et al. (1995) examined the feed consumption of 6 and 16 week old rabbits over 24 h periods. The consumption was high during the night; it declined at the beginning of the light period, and then, some hours before the lights were turned off, it increased again.

Wild rabbits are outside the warren and active during the dark period, and this is the time when they consume food and defecate hard faeces. During daytime they are in the warren and practise ceacotrophy. Jilge (1974) observed that adult male rabbits, wearing plastic collars to prevent ceacotrophy, excreted soft faeces during the first half of the 12 h light phase, starting at about the time when the light was switched on at 06:00 h and lasted 6.5–9.1 h. In the control group without collars, the soft faeces excretion period was about one hour longer. While soft faeces were being excreted, food intake was reduced considerably in collared as well as in non-collared animals. The excretion of hard faeces occurred during the rest of the light and for the whole of the dark phase. The duration of hard faeces excretion was between 15.1 and 17.4 h for collared rabbits and it was shorter (14.0–16.1 h) for noncollared animals. Hörnicke et al. (1984) also observed the photoperiod-dependent regulation. Carabaño and Merino (1996) examined the effect of ileal cannulation on feed intake, and soft and hard faeces excretion. The excretion of soft faeces started in the morning with a peak at 11:00 h and that of hard faeces started the late afternoon and remained at a high level till the beginning of the next light period.

3.2. Changing the time of feed and water consumption and hard and soft faeces excretion

The dominant role of dark was proven by Prud'hon et al. (1975) who examined the effect of once a day and once every two days water administration on daily feed consumption. At the time of daily water administration the feed intake suddenly increased for two hours. During daytime it was at a low level, and then it began to increase before the dark period and remained at a high level until the lights were turned on. The same tendency was observed when water was given every other day. After water administration, the feed intake increased for three hours, then during the day, night and the next day it was at low level. At the next dark period the feed consumption was high again. In another experiment the light and dark periods were exchanged (Prud'hon et al., 1978). The shift of the light phase did not modify the quantitative feed intake, but the time of feed and water consumption moved day by day and rabbits adapted to the new light/dark period after about four weeks.

Reyne et al. (1979) changed the 14L:10D photoperiod to continuous 24 h lighting. The activity of feed and water consumption continued in a daily periodic fashion, but the average duration between two periods was 25.3 h. Jilge (1982) switched the 12L:12D photoperiod to 24 h lighting and later returned to the original 12L:12D cycle. With 24 h lighting, the free-running circadian rhythm of ceacotrophy was monophasic with a length of 24.7 h. Following restoration of the 12L:12D photoperiod, the rabbits re-established their original caecotrophy pattern. When the rabbits were housed in continuous dark, they consumed more feed than the control group, and the length of the circadian period was 23.5–23.8 h. The duration of soft faeces excretion was about 5–6 h. It can be concluded, that in continuous light or continuous dark, the daily rhythms of rabbits are under control of the

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