proxima
LIGHTING SOLUTIONS
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Non-Visual Effects of Light on Pets

Part II

Vision in horses and the effects of colored LED light on them

Horse has one of the largest eyes among mammals. They have a clear retinal surface that provides a relative magnification of the image that is 50% larger than the human eyes [1] (Figure 1).

Horses have superior night vision. They also have better vision on slightly cloudy days than sunny days [2]. The large eye of the horse improves achromatic tasks, particularly in dim conditions [3].

However, horses are less able than humans to adjust to sudden changes in light. For example, when moving from a bright day into a dark place it takes time to be compatible with new condition. This may frighten a horse simply because it cannot be seen adequately. It is also essential in riding; quick movement from light to dark or vice versa will make it difficult for the horse to recognize objects.

Figure 1 The eye of a horse [4]

Until quite recently just four colors had been tested on the horse in this way, with inconsistent results. Studies on horses' ability to discriminate certain wavelengths from grey have shown different results. Although all of these studies concluded that the horse had the ability to discriminate blue from grey, the results for red, green, and yellow were variable [5]. One of the researches obtained significant results regarding the discrimination of two colors, blue (462 nm) and red (700 nm), but not green (496 nm).

Another researches presented the ability to see more colors, blue (470, 474, 482 nm), yellow (579, 582, 583 nm) and green (532, 533, 545 nm) and a tendency for red (609, 611, 615 nm) [6]. Another researcher provided that the horses in his study could discriminate yellow best, followed by green and then blue, but had some difficulty with red. One other research group showed that the horses in this study successfully reached the criterion for learning (85% correct responses) with red and blue—one of the subjects performed at chance levels only for yellow and green [7]. However, the other observation concluded that horses have the ability to distinguish all four colors (blue 470 nm, red 617 nm, green 538 nm, yellow 581 nm) successfully, but some individuals with partial color blindness have been reported.

For the purpose of obtaining general knowledge on the effects of colored light on horses, the consequences of short term exposure of different colors of light, red, blue, green and yellow, on various behavioral and physiological parameters were investigated in 20 healthy stallions of the breed Freiberger (Figure 2). The observation lasted five weeks. Four horses were examined each week. Each horse was exposed to only one color of light per day of the week.

Figure 2 Light-box with ceiling-mounted LED lights at white light and horse during illumination with red, green, blue and yellow light (from left to right). White one is for control [6].

For this study healthy horses were chosen. Under this condition, healthy horses may be affected to a lesser extent or not at all in comparison to the animals with specific disorders or diseases.

This study aimed to observe the effects of colored light on one behavioral parameter and the body core and surface temperature. Based on analyses, the illumination with colored light seemed to be not stressful for the horses. There was no evidence that treatment or exposure to colored light caused stress in horses. Still, also, it had a generally becalming effect. Given that light plays a vital role in controlling biological and physiological mechanisms, it is considered that lighting, regardless of color, had a calming effect on horses in general. But there should be more studies on the application of colored light, and horses with described disorders and diseases should be examined before, during, and after color light therapy [6].

Vision in chickens and laying hen and Preference testing for UV light spectrum and intensity in laying hens

Considering the hen's vision is important when judging how dim artificial lighting may influence her welfare.

The chicken's field of view is approximately 300° with only a 30° overlap in which binocular vision could occur.

The hen's eyes are comparatively large and of similar weight to the brain. They are also relatively immobile in theirs socket, so with rapid head movements aided by a long, flexible neck and lightweight head, large changes in view are attained in the eyes. Adult hens have approximately 17 mm wide, 14 mm deep and is surprisingly flattened eyes. This flattening may allow an image to be focused across a wider area of the retina than for rounder eyes [7] (Figure 3).

Figure 3 The eye of a hen [8]

Light has significant impact on a hen's behavior, production, physiology and welfare. So it is a critical factor in the laying hen industry. The physical properties of light include photoperiod, intensity (brightness) and wavelength (color), and etc. affect in layer production systems. Previous researches demonstrated that the photoperiod of light is essential for sexual maturity and egg production. Intensity can have influence on the development of feather pecking behaviors. Wavelength is processed by different photoreceptors in the eye that can then stimulate performance and physical activities. Avian species are able to see part of the UV light spectrum (315–400 nm), called UVA wavelengths because of having a fourth retinal cone which is extra. The UVB light spectrum (280–315 nm) is not visually detectable by hens but can penetrate the skin of a chicken's feet, wattles, and comb. These UVB wavelengths play a key important role in the production of vitamin D3 which promotes intestinal absorption of calcium and phosphorus and improves bone mineralization and bone growth. This study showed that chickens that experience the least amount of sunlight preferred lights that approximated daylight including high intensities of these lights. When a combination of UVA and B wavelengths were presented, preferences were decreased more sharply, suggesting hens avoided the harmful radiation. Lower levels of UVA/B lead to more behavioral expression of foraging and comfort behaviors. This indicates that hens may positively respond to sunlight access in a free-range setting but when the sunlight is intense, hens may need protective measures (e.g., shelter) to protect themselves from certain levels of UV radiation and intensity [9].

Vision in cattle and the effects of light on them

The field of vision of cattle is 330 degrees. Their monocular vision has no deep understanding because they have no vision behind them. They are blind in front of their noses [10]. According to the book "Improving Animal Welfare" by Temple Grandin, cattle lack the red retinal receptor and can only see yellow, green, blue, and violet colors [11] (Figure 4).

Cows were housed in an individual tie stall barn with rubber mats and wood shavings as bedding material. Cows were fed on a feed bunk with dividers to separate cow’s feed (Figure 5). There is no access for barns to natural day light.

Figure 4 The eye of a cow [12]

Figure 5 Feed bunk with dividers to separate cow's feed [13]

During the 33days treatment period red and blue LEDs were irradiated during daytime. Experimental data were collected during the last five days of treatment period. The LED light placed between the cows was provided by 22 Grow light LED lights (Figure 6).

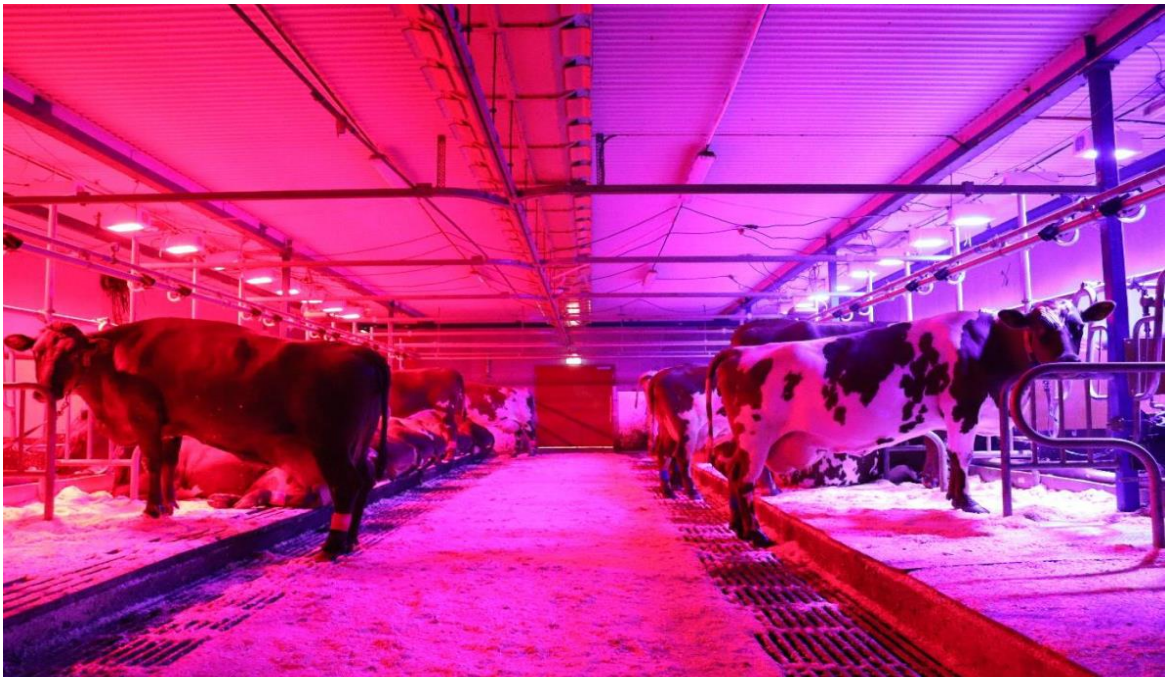

Figure 6 Cows were treated with red and blue LED light [13]

Milk yield at the start of the experiment averaged 20-25 kg per day and did not change during the four weeks during the four weeks between the baseline and LED period. There was no significant difference in milk yield when cows were treated with red and blue LED light.

Milk yield is expected to decrease 2% per week after the peak of lactation. This means an expected loss of 1.6 kg during our test. The fact that milk yield was maintained suggests that the LED light stimulated a more persistent lactation.

These results suggest that LED lights can affect feed sorting and spread further throughout the day. It is also possible that the LED lights maintain the function of the milk because there was no difference in the amount of milk in one month after the peak of lactation. The response of the cows to red LED light is very interesting because, as mentioned above, it is convincingly stated that cows do not have a good vision for red color. Of course, this issue needs further investigation [13].

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