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Popular Article

Physiological Effects of Photoperiodism in Avian Management

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Introduction

Light is a crucial management factor in birds as it affects production efficiency, physiological and behavioural response of poultry. The reproductive performance of the laying hen is dependent on the duration, intensity and quality of light used during housing. This makes the use of artificial lighting programmes in modern poultry houses for maintaining egg production. In addition to the impacts on behavioural output, light wavelength also influences fear and stress levels due to release of oxygen free radicals.

Birds have light-sensitive photoreceptors located in the retina of the eye, the pineal gland and the hypothalamus. The cones of the retina are responsible for photic colour vision and are tetrachromatic in fowls, containing four different photoreceptive cone pigments. In addition to being able to see coloured light, poultry can perceive the ultraviolet (UV) part of the spectrum, due to the presence of an extraretinal cone in the eye that allows the transmission of radiation at wavelengths shorter than 400 nm.

Physiology of light mechanism in birds

Light stimulation is transmitted to the hypothalamus through the optic nerve and acts on photoreceptors to stimulate the secretion of GnRH, which reaches the anterior pituitary through the pituitary portal system. Light also causes the secretion of follicle-stimulating hormone (FSH) and Luteinizing hormone (LH). When these hormones reach the ovary, they promote the development and maturation of follicles. The developing follicles produce Oestradiol which stimulates the development of the reproductive tract, secondary sex characteristics and is involved

in ovulation. In addition, it stimulates the hepatic synthesis of major yolk components and increases the activity of calcitriol, which increases calcium levels in the blood for shell synthesis. Progesterone is involved in regulating ovulation. Estrogen, FSH and LH promote the sexual maturity of the chicken and maintain production performance.

Ovulation depends on an endogenous mechanism that is closely related to external factors. The synchronization of these factors is called circadian rhythm and allows ovulation to occur regularly during lay. Layers use circadian rhythms to perceive the duration of the day and they are most sensitive to light between 11 and 15 hours after the light is turned on. During this photosensitive phase, a neural-hormonal mechanism controls the reproductive functions. Layers are not constantly stimulated during the entire photoperiod, but only on two important times of this period. This is called the photosensitive phase and will determine if the bird will perceive the day as long or short. It must be noted that birds are not stimulated when days are short, whereas long days will trigger and maintain the hormonal flow that controls ovulation.

Lighting system in poultry industry

Artificially changing the photoperiod is one of the most powerful management tools available for breeding poultry. It may delay or advance the onset of lay, synchronize egg-laying time and influence egg production rate, eggshell quality, feed efficiency, and egg size. The reproductive system is not stimulated when days are short. On the other hand, long photoperiods can stimulate the sexual function of layers and increase egg production. Long days are those which photoperiod is longer than 12 hours. As the stimulation of reproduction requires a light period, studies on artificial lighting management to delay or to stimulate gonadal activity has been considered important.

Incandescent light, light emitting diodes (LED) and fluorescent lights are the different types of lighting being currently used in the poultry industry.

LEDs are among the most efficient light sources, as they can be manufactured to deliver a defined and stable spectral output and are dimmable. Poultry producers can make use of LEDs that emit single light colors (red, blue or green) as well as white light with a spectral output of 400–700 nm.

UV is part of the electromagnetic radiation spectrum that lies between 100 and 400 nm and is divided into three types according to their wavelength: UVA (315–400 nm), UVB (280–315 nm) and UVC (100–280 nm). Colored light is defined by different wavelengths, with avian photoreceptive pigments having a maximum sensitivity to violet (415 nm), blue (455 nm), green (508 nm), and red light (571 nm). These different wavelengths are known to exert

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variable effects on laying hen production and egg quality. Factors such as bird strain and age, as well as light intensity may also contribute to this variation.

Red light is known to have an increased ability to stimulate a photo sexual response in birds compared to blue/green light. This is due to light of shorter wavelengths (400–500 nm) having more absorption through the cranial tissues resulting in a reduced stimulatory effect on the hypothalamus. Light with longer wavelengths (red light) contains more energy and can penetrate better through the skull and brain tissue to reach the hypothalamus.

However, some studies have shown that an inability of light with shorter wavelengths to stimulate a photo sexual response could be due to their sub-optimal intensity rather than a lack of response to that light. Therefore, it has been suggested that shorter wavelengths (blue/green light) require higher intensities to stimulate hypothalamic photoreceptors. Adequate light manipulation involves both the quantity (duration and intensity) and quality (color or wavelength) of the light.

The beneficial effects of exposure to UV light, specifically UVB, may come from its involvement for the synthesis of vitamin D3 from 7-dehydroxycholesterol in the skin. Vitamin D3 promotes the body's absorption of calcium and phosphorus, thereby playing a role in bone metabolism.

Birds fed a diet deficient in vitamin D3 often have sub-optimal growth and severe leg weakness, but the small amount of UV light found in white, fluorescent light has been shown to reduce these symptoms and ensure normal development. The biologically active form of vitamin D (1,25-dihydroxycholecalciferol) is required for the regulation of calcium absorption and excretion. It can initiate the mobilization of calcium reserves from bones for eggshell production and can improve calcium absorption.

Thus, these impacts on bird behavior may suggest that lighting programs with varying wavelengths may be a usable tool to improve welfare and production.

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