***Review Article***

**The effects of various light parameters (intensity, duration, darkness, source, and color) on broiler performance**

**Abstract:** Among other factors, light intensity and perch use stand out as important management tools that can positively impact broiler welfare. Recent advancements in lighting technology provide new opportunities for improving traditional lighting programs within chicken houses. The aim of this review is to understand the impact of light intensity on broiler chicken productivity. The result showed that color of light exerts variable effects on broiler performance. Both light intensity and light duration were identified as key factors in boosting overall broiler performance.

**Keywords:** Chicken Productivity, Broiler farming, photoperiod, light intensity

**Introduction**

“Broiler farming involves various managerial factors that contribute to the overall welfare of broiler chickens. Among these factors, light intensity and perch use stand out as important management tools that can positively impact broiler welfare. The effects of light intensity on the welfare of broiler chickens can be controlled physically and behaviorally. It has been observed that low light intensity generally has negative effects on poultry welfare” (Rault et al., 2017). “Light is as an important management tool to regulate broiler production and welfare by modulating various behavioral and physiological pathways. Artificial lighting for broilers consists of 3 aspects: photoperiod, wavelength, and light intensity. All of these aspects have significant effects on broiler production and welfare. The effects of photoperiod on broiler production and welfare were intensively studied in the past” (Classen and Riddell, 1989; Classen et al., 1991; Sørensen et al., 1999; Classen et al., 2004). Similarly, several studies have investigated the effects of wavelength (Rozenboim et al., 1999; Lewis and Morris, 2000; Rozenboim et al., 2004).

“Recent advancements in lighting technology provide new opportunities for improving traditional lighting programs within chicken houses. Traditional light bulbs have gradually been replaced by LED lamps in the last ten years” (Gongruttananun and Guntapa 2012; Santana et al 2014; ElSabrout et al 2022b). “The main advantage of the LED is the energy savings (80% less energy is wasted than with Inc bulbs and 50% less than with Fl), longer shelf life and color diversity”, as shown by Molino et al (2015).

The primary purpose of broiler breeder husbandry and management is to produce eggs with high-quality chicks. Since breeder fertility and production are highly sensitive to surrounding environmental conditions, breeder hens must be housed in optimal conditions throughout their life stages.

**Importance of light in poultry physiology**

“Light is considered as one of the most predominant environmental factors for birds. Many physiological and behavioral processes are regulated through it and it also affects growth rate” [Rault et al., 2017]. “It is important for sight both visual acuity and colour discrimination. Light helps the bird to establish rhythmicity and synchronize many essential functions, including body temperature and various metabolic steps that enhance feeding and digestion. Actually, nutrient concentration, feed form and light act independently and also interactively. Light also stimulates secretory patterns of hormones that have a role in growth, maturation, and reproduction” [Rozenboim et al., 2004, Olanrewaju et al., 2016]. Especially, light has an impact on the pineal gland and helps in synchronization of circadian rhythm and inhibiting melatonin release (Schwean et al., 2016).

**Effect of light parameters on broiler production-**

1. **Light intensity**

“The growth and development is better in blue or green light over red or white light. Broiler behavior is powerful of candle power. Generally, brighter light increases the activity of broiler, while lower light intensity can lead to cannibalism” [Cherry P and Barwick, 1962]. “Young chick generally prefers brighter light. Producers often use trendy electronic system to extend candle power for brief periods throughout grow out to extend exercise and thereby cut back skeletal and metallic disorders. Young chick generally prefers brighter light” (Cherry P and Barwick, 1962).

1. **Light duration**

“Lighting duration, i.e., photoperiod, is the second major aspect of light that will alter broiler performance. Intermittent photoperiod significantly increases weight gain, feed-gain ratio, mobility and carcass yield with a decrease in mortality rate” [Arowolo et al.,2018]. “Different photoperiodic regimes have been applied and tested over the years, while almost all of them are been proved to be more beneficial for broiler production compared with conventional near-continuous lighting” [Farghly et al., 2019] . Lighting duration is largely dependent upon the age of the chickens involved and type of housing in use.

It has also been noticed that regardless of market age short day lengths (i.e. 14 hours of light) lead to a reduced growth rate. But, increasing day length to 23 hours a day also has a negative impact on the growth rate.

1. **Darkness**

“Research has shown that darkness is as important to the growth and health of broilers as light” [Classen, 1991]. The physical activity and walking ability are markedly improved when darkness is included in the lighting programme [Schwean et al., 2016]. “Broilers reared under longer periods of darkness are found healthier than under long daylight conditions. Melatonin, secretion from the epiphysis is concerned with rhythms and digestion, and secretion of lymphokines. Daily dark periods are necessary to ascertaion traditional humor patterns of integral secretion. Melatonin is released during darkness. Birds grown in spare darkness have fewer health issues, including certain death, spiking mortality and leg problem than those maintained in continuous or near continuous light” (Classen, 1991).

1. **Source of light**

“There are different kinds of lamps available to poultry producers: incandescent, fluorescent, metal halide, highpressure sodium, CFL (compact fluorescent) and LED (light emitting diode). All are in use in poultry facilities for laying hens, breeder flocks, broilers, and turkeys. No significant differences were found on weekly body weight, body weight gain and after treating the birds with different types of light sources- natural light, Incandescent (INC), CFL and LED” [Nissa et al., 2011, Sharideh and Zaghari, 2016]. “In contrast, some researchers have found contradictory results. Rogers and colleagues reported that body weight was higher at day 42 when reared under incandescent lamps compared to cold cathode fluorescent (CCFL)” [Rogers et al., 2015]

1. **Color of light**

“Color of light exerts variable effects on broiler performance. There is somewhat equal distribution of wavelengths in day. Birds sense light through their eyes and through photo sensitive cells in the brain. Blue light weight stimulates growth in chickens while orange red stimulates reproduction. Light of various wavelength has varied stimulatory effects on the tissue layer and might end in activity changes that may have an effect on growth and development. Broilers under blue and green light became significantly heavier than red or white zone. Green light accelerates muscle growth and stimulates growth at an early age, whereas blue light stimulates growth” [Beane W., et al., 1962, Classen H., et al., 1991]. “Growth in broilers is affected by light spectra. Broilers under blue or green light become significantly heavier than those reared under red or white light” [Rozenboim et al., 2004].

Table 1: Effect of green, red and white light exposure during incubation of broiler eggs [Archer, 2017].

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Criteria**  | **Dark**  | **Green**  | **Red**  | **White**  |
| Hatchability  | -  | -  | Increased  | Increased  |
| Non-defect chick  | -  | Improved  | Improved  | Improved  |
| Post-hatch 45-day weight  | Not affected  | Not affected  | Not affected  | Not affected  |
| Feed conversion  | Not affected  | Not affected  | Not affected  | Not affected  |
| Fear response during isolation  | -  | -  | Reduced  | Reduced  |
| Tonic immobility  | -  | -  | Reduced  | Reduced  |
| Humoral immunity  | -  | -  | Higher  | Higher  |
| Plasma corticosterone  | -  | Lower  | Lower  | Lower  |
| Plasma serotonin  | -  | Higher  | Higher  | Higher  |

**Conclusion**

Recent advancements in lighting technology provide new opportunities for improving traditional lighting programs within chicken houses. Breeder fertility and production are highly sensitive to surrounding environmental conditions, breeder hens must be housed in optimal conditions throughout their life stages.

Disclaimer (Artificial intelligence)

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Details of the AI usage are given below:

1.

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**References**

Classen, H. L., C. Riddell, and F. E. Robinson. 1991. Effects of increasing photoperiod length on performance and health of broiler chickens. Br. Poult. Sci. 32:21–29.

Archer GS. Exposing broiler eggs to green, red and white light during incubation. Animal. 2017; 11(07):1203- 1209.

Beane W., et al. “The effect of light on body weight and feed conversion of broilers”. Poultry science 41.4 (1962): 1350- 1351.

Classen H., et al. “Effects of increasing photoperiod length on performance and health of broiler chickens”. British Poultry Science 32.1 (1991): 21-29.

Rogers AG, Pritchett EM, Alphin RL, Brannick EM, Benson ER. I. Evaluation of the impact of alternative light technology on male broiler chicken growth, feed conversion, and allometric characteristics. Poult Sci. 2015; 94(3):408-414

Nissa SS, Sheikh IU, Banday MT, Khan AA, Zaffer B. Effect of different light sources on the performance of broiler chicken reared under deep litter system of management. 2018; 6(4):398-400.

Sharideh H, Zaghari M. Effect of light emitting diodes with different colour temperatures on immune responses and growth performance of male broiler. Ann Anim Sci. 2016; 17(2):545-553.

Classen HL, Ridell C, Robinson FE. Effects of increasing photoperiod length on performance and health of broiler chickens. Br Poult Sci. 1991; 32(1):21-29.

Schwean-Lardner K, Vermette C, Leis M, Classen HL. Basing Turkey lighting programmes on broiler research: A good idea? A comparison of 18 daylength effects on broiler and Turkey welfare. Animals. 2016; 6(5).

Classen, H. L., C. B. Annett, K. V. Schwean-Lardner, R. Gonda, and D. Derow. 2004. The effects of lighting programmes with twelve hours of darkness per day provided in one, six or twelve hour intervals on the productivity and health of broiler chickens. Br. Poult. Sci. 45:S31–S32.

Classen, H. L., and C. Riddell. 1989. Photoperiodic effects on performance and leg abnormalities in broiler chickens. Poult. Sci. 68:873–879.

Sørensen, P., G. Su, and S. C. Kestin. 1999. The effect of photoperiod:scotoperiod on leg weakness in broiler chickens. Poult. Sci. 78:336–342.

Rozenboim, I., I. Biran, Y. Chaiseha, S. Yahav, A. Rosenstrauch, D. Sklan, and O. Halevy. 2004. The effect of green and blue monochromatic light combination on broiler growth and development. Poult. Sci. 83:842–845.

Rozenboim, I., B. Robinzon, and A. Rosenstrauch. 1999. Effect of light source and regimen on growing broilers. Br. Poult. Sci. 40:452–457.

Lewis, P. D., and T. R. Morris. 2000. Poultry and colored lights. World’s Poult. Sci. J. 56:189–207.

Rault JL, Clark K, Groves PJ, Cronin GM (2017) Light intensity of 5 or 20 lux on broiler behavior, welfare and productivity. Poult Sci 96(4): 779-787.

Gongruttananun N, Guntapa P (2012) Effects of red light illumination on productivity, fertility, hatchability and energy efficiency of Thai indigenous hens. Kasetsart Journal (Natural Science) 46:51-63.

Santana MR, Garcia RG, Naas IA, Paz IC, Caldara FR, Barrrto B (2014) Light emitting diode (LED) use in artificial lighting for broiler chicken production. Engenharia Agrícola 34:422-427.

El-Sabrout K, El-Deek AM, Ahmad S, Usman M, Dantas MR, Souza Júnior JB (2022b) Lighting, density, and dietary strategies to improve poultry behavior, health, and production. Journal of Animal Behaviour and Biometeorology 10:2212.

Molino AB, Garcia EA, Santos GC, Vieira Filho JA, Baldo GA, Almeida Paz IC (2015) Photostimulation of Japanese quail. Poultry Science 94:156-161.

Rault JL, Clark K, Groves PJ, Cronin GM. Light intensity of 5 or 20 lux on broiler behavior, welfare and productivity. Poult Sci. 2017; 96(4):779-787.

Rozenboim I, Chaiseha Y, Rosenstrauch A, Sklan D, Yahav S, Halevy O. The effect of a green and blue monochromatic light combination on broiler growth and development. Poult Sci. 2004; 83(5):842-845.

Olanrewaju HA, Miller WW, Maslin WR, Collier SD, Purswell JL, Branton SL. Effects of light sources and intensity on broilers grown to heavy weights. Part 1: Growth performance, carcass characteristics, and welfare indices. Poult Sci. 2016; 95(4):727-735.

Schwean-Lardner K, Vermette C, Leis M, Classen HL. Basing Turkey lighting programmes on broiler research: A good idea? A comparison of 18 daylength effects on broiler and Turkey welfare. Animals. 2016; 6(5).

. Cherry P and Barwick MJBPS. “The effect of light on broiler growth: II. Light patterns”. British Poultry Science 3.1 (1962): 41-50.

Farghly MF, Rehman ZU, Ahmad EAM, Mahrose KM, Yu S. Implementation of different feeding regimes and flashing light in broiler chicks. Poult Sci, 2019.

Arowolo MA, He JH, He SP, Adebowale TO. The implication of lighting programmes in intensive broiler production system. Worlds Poult Sci J. 2018; 75:1-12.