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Light Management in Broilers: An Overview

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Abstract

Broilers are reared in various production systems. The three important aspects of light which play a pivotal role in determining the production performance of broilers are intensity, duration and colour. It has been noted that broilers grow better during constant photoperiod while darkness is important for the welfare of the birds. Further, Broilers under blue or green light become significantly heavier than those reared under red or white light. Thus, it is necessary that a particular lighting program considering production and welfare concerns may be standardized and followed for optimum production performance in broiler operation

Keywords: Broilers; Photoperiod; Light Intensity; Scotophase.

Introduction

Globally, chickens are reared in a variety of production systems. These include outdoor enclosures that basically utilize natural climatic conditions, production house of various sizes and construction that have little to extensive control over light and other environmental factors, and very large homogeneous houses that allow precise control of environmental factors, including temperature, humidity, air velocity, rate of air exchange, gases, light intensity, duration and color. Light as an environmental factor which consists of three different aspects: intensity, duration, and wavelength. Light intensity, color, and the photoperiodic regime affect the physical activity of broiler chickens (Lewis and Morris, 1998).

The broiler producer must consider several critical factors in the design of a lighting program. Housing type is the first concern. Some broiler houses have dark and light colored curtains in facilities but most of the broilers are reared in clear curtained sidewall housing. Broiler producers with clear curtains and/or open sidewall houses are restricted in lighting alternatives and are forced to design lighting programs around the limitations of natural daylight/length. Houses with dark curtains or solid sidewalls allow the producer to establish lighting systems that control intensity, duration, and wavelength throughout the growth period. When considering lighting programs as a management tool, both light intensity and duration are factors that are normally considered. In most situations, light provided by incandescent sources is used.

Vision

The most important visual abilities of poultry are spectral and flicker sensitivities as well as accommodation and acuity. Domestic fowl have a number of adaptations to their color apparatus not shared by humans. They possess three photoreceptors compared with just two (rods and cones) receptors in humans. The additional photoreceptor is a double cone, but its function is not clear, though it does respond to incident light (Prescott and Wattes, 1999; King-Smith, 1971). Birds have four photo reactive pigments associated with cone cell that are responsible for photopic color vision, while humans have only three pigments. The pigments in bird cones are maximally sensitive at wavelengths of 415, 455, 508 and 571 nm, while those of humans are maximally sensitive to wavelengths of 419, 531 and 558 nm (Yoshizawa, 1992; Dartnall *et al.*, 1983).

Light

Light is a powerful exogenous factor in control of many physiological and behavioral processes. Light may be the most critical of all environmental factors to birds. It is integral to sight, including both visual acuity and color discrimination (Manser, 1996). Light allows the bird to establish rhythmicity and synchronize many essential functions, including body temperature and various metabolic steps that facilitate feeding and digestion. Of equal importance, light stimulates secretory patterns of several hormones that control, in large part, growth, maturation, and reproduction.

Spectral Sensitivity of the Domestic Fowl

The spectral sensitivity of broiler fowl has been determined in a behavioural test. Generally, the birds showed a peak sensitivity between 540<l <577 nm. The results agree with electrophysiological data between 507<l <694 nm and psychophysical data between 500<l <700 nm, data showed higher sensitivities between 380<l <507 nm compared with electro-physiological findings. Findings confirm that broilers can 'see' into the UVA range and that their spectral sensitivity is different to the human. The implication of this is that the measurement of light intensity in poultry housing using the lux unit does not accurately describe the intensity perceived by fowl (Prescott and Wattes, 1999).

Blue light has a calming effect on birds, while red will enhance feather pecking and cannibalism. Blue-green light stimulates growth in chickens, while orange-red stimulates reproduction (Rozenboim *et al.*, 1999).

Light Intensity

Broiler behavior is strongly affected by light intensity. Generally, brighter light will foster increased activity, while lower intensities are effective in controlling aggressive acts that can lead to cannibalism. Varying light intensities are often applied to manage the birds. Light intensity has significant effect on blood biochemical parameters like pH, Na^+, K^+, Cl^-, pCO_2 and Hb concentrations (Olanrewaju *et al.*, 2012).

Young chick (1 to 28 days of age) generally prefer brighter light (~20 lx) and broilers prefer blue or green light over red or white light.(Berk, 1995; Prayitno *et al.*, 1997).

Photoperiod

Duration of the photophase or photoperiod is the second major aspect of light that will alter broiler performance. Different photoperiodic regimes have been applied and tested over the years, while almost all of them have been shown to improve broiler welfare with conventional near-continuous lighting (Gordon, 1994). Lighting duration is largely dependent upon the age of chickens involved and type of housing in use. Research and discussion continue in an attempt to define the optimal photoperiodic regime suitable for broiler chickens. However, results to date suggest an absolute minimum uninterrupted dark period of 4 hours should be given, but the requirements for sleep may be higher at certain points of the growing period (Blokhuis, 1983).

Scotophase

Broiler lighting schedules can be characterized in a number of ways, including the number of hours of scotophase (darkness) and how many periods of darkness are included in each 24 hour (h) cycle. Research has shown that darkness is as important to growth and health of broilers as light. It was hypothesized that short photoperiods early in life will reduce feed intake and limit growth. Recent research comparing 12 hour light (L):12 hour dark (D), 16L:8D and 20L:4D lighting schedules demonstrated clearly that longer periods of darkness prevent regular access to feed and consequently reduce feed intake and limit growth. (Classen, 2004a). Classen *et al*. (2004b) also compared lighting programs with 12 h of darkness per each 24 h period provided in 1, 6, or 12 h intervals. Their study indicated that early growth rate was significantly reduced by longer periods of darkness, but gain from 14 to 35 day (d) as well as final body weight was not affected by lighting programs. Feed conversions were higher for 12 L: 12D and two 6L: 6D periods per each 24 h period than 12 (1L:1D) periods per each 24 h period. The 12L: 12D treatment resulted in lower mortality than the 12 (1L: 1D) treatment and the 2 (6L: 6D) was intermediate.

Gait scoring has been proposed as an indicator of leg health and consequently broiler welfare (Sanotra *et al*., 2002; Garner *et al*., 2005). Broilers reared under a 2 (6L:6D) until 33 d of age showed higher gait scores, thus more leg problems and poorer general welfare, than broilers reared under a 12 (1L:1D) schedule (Garner *et al.,* 2005) Longer dark periods were associated with lower mortality and improved gait scores. Reduced early growth which increased leg strength was proposed as the rationale of this effect. Broilers reared under longer periods of darkness are reported to experience better health than counterparts under long daylight conditions. Melatonin is a hormone released from the pineal gland that is involved in establishing circadian rhythms of body temperature, several essential metabolic functions that influence feed/water intake patterns and digestion and secretion of several lymphokines that are integral to normal immune function (Apeldoorn *et al*., 1999).

Daily dark periods are necessary to establish normal secretory patterns of melatonin. Melatonin, which is synthesized in the pineal gland and retina of birds, is released during the hours of darkness in response to the activity of serotonin-N-acetyltransferase, the enzyme that catalyzes the synthesis of melatonin in both the retina and pineal gland (Binkley *et al*., 1973). Birds provided with sufficient dark periods have fewer health related problems, including sudden death syndrome, spiking mortality and leg problems than those maintained in continuous or near continuous light (Apeldoorn *et al*., 1999; Moore and Siopes, 2000). Livability, average BW, feed conversion rate and percentage condemnations were improved in broilers exposed to restricted photoperiods, as compared to broilers subjected to continuous light (Classen, 2004a).

Increased heterophil: lymphocyte ratio is an accepted indicator of stress in chickens. Broilers reared under continuous light had a higher heterophil: lymphocyte ratio and experienced greater fear response, as indicated by increased tonic immobility time than birds reared under a 12 hour light: 12 hour dark photoperiod (Zulkifli *et al*., 1998). Continuous light disrupts the diurnal rhythm and has some welfare concerns. Among those are high prevalence of leg and skeletal disorders in poultry and affected birds may even experience difficulty in getting to feed and water. In addition, use of continuous or near-continuous light has proved to be stressful and results in greater mortality (Sanotra *et al*., 2001, 2002; Wong-Valle *et al*., 1993; Freeman *et al.,* 1981).

Introduction of a moderate day length of 16 hour is associated with potential welfare benefits including lower physiological stress, improved immune response, increased sleep, increased overall activity and improvement in bone metabolism and leg health (Gordon, 1994; Davis *et al*., 1997; Rozenboim *et al.,* 1999b; Classen *et al*., 2004b).

Constant Photoperiod

When photoperiod is maintained at a constant level throughout the growth cycle of broiler chickens, shorter day length is associated with slower growth. If given a choice, chickens prefer to eat during the photoperiod, although they will eat during darkness if insufficient periods of light are provided (Li *et al*., 1995).

Intermittent Lighting

Research on intermittent lighting has been extensive but complicated by a wide variety of light-dark cycles and management systems. However, intermittent lighting programs have frequently resulted in superior broiler productivity in comparison to constant light. (Classen, 2004a; Rahimi *et al*., 2005) Intermittent lighting frequently reduces the incidence of leg disorders and has also been shown to reduce sudden death syndrome. Circadian (daily) rhythms in activity and metabolism are well recognized in diurnal poultry species. Entraining endogenous circadian rhythms can be accomplished by a number of factors such as housing, but light is almost certainly the most important factor.(Buckland, 1975; Simmons, 1986; Classen and Riddel, 1989; Classen, 2004). Alternative lighting programs can be classified into

- Intermittent (e.g., 1hour light:3 hour darkness repeated (Wilson *et al*., 1984),
- Restricted (e.g.,16 hour light:8 hour darkness (Robbibs *et al*., 1984),
- Combination of intermittent and restricted (e.g., 12 hour light followed by 15 min light:2 hour

darkness repeated over 12 hours (Quarles and Kling,1974),

- Increasing photoperiod schedules (Renden *et al*., 1996).

Broilers on intermittent photoperiods exhibited less stress, as measured by plasma corticosterone, than counterparts on continuous light. Plasma corticosterone is known to be elevated in stressed broilers (Buckland *et al*., 1974; Puvadolpirod and Thaxton, 2000a-d; Puvadolpirod and Thaxton, 2000a-d; Olanrewaju *et al*., 2006).

Male broiler chickens raised in near continuous lighting (23hour light:1 hour darkness) and intermittent lighting (1 hour light: 3 hour darkness, I hour light) repeatedly had higher growth rates, higher plasma growth hormone levels and testosterone concentrations than birds under a continuous lighting (24 hour light: 0 hour darkness) regimen (Kuhn *et al*. 1996). Performance of broiler chickens is improved by intermittent lighting of repeated cycles of 1 hour light and 2 hour darkness schedules compared to continuous lighting.

Increasing Photoperiod

Male broilers subjected to an increasing photoperiod had larger testes and higher plasma androgen concentrations at 7 week than birds under a continuous light regimen. Chickens reared under increasing photoperiod had higher plasma androgen concentrations at 7 week compared to those under constant photoperiod, but light intensity had no effect (Charles *et al*. 1992).

Lighting program beginning with an extended dark period and thereafter gradually increasing the day length results in reduced early growth rate, reduced feed intake and improved feed conversion ratio, compensatory growth, stimulated sexual maturity as early as 7 week and improved chicken livability when compared with those exposed to near continuous constant photoperiod program (Charles *et al*. 1992). Potential health benefits associated with increasing photoperiod may result from reduced early growth rate, increased activity, increased and rogen hormone production, changes in metabolism or combinations of these factors (Classen and Riddell, 1989).

Color of Light

It is dictated by wavelength and it exerts variable effects on broiler performance. None of the commonly used types of fluorescent light emits appreciable amounts of ultraviolet A light (UVA, ë 320-400 nm). Daylight has a relatively even distribution of wavelengths between 400 and 700 nm. Birds sense light through their eyes (retinal photoreceptors) and through photosensitive cells in the brain (extra-retinal photoreceptors). The ability of chickens to visualize color is similar to that of humans, but they cannot see as well when exposed to short wavelengths (blue-green). Specific light wavelength may have an impact on production and characteristics of broilers. During the early period, short wavelengths appear to stimulate growth. However, when the bird approaches the time of sexual maturity, long wavelengths (orange-red) increase growth and are effective in stimulating sexual hormonal pathways that culminate in fertile egg production. 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. Green light accelerates muscle growth and stimulates growth at an early age, whereas blue light stimulates growth in older birds (Halevy *et al*., 1998) (Rozenboim *et al*., 1999a, b; 2004).

Conclusion

Light management in broilers has multidimensional effect on the bird's welfare as well as producer's profit. Hence, variations in light source, duration, color and intensity have to be judiciously handled. Further, a particular lighting program considering production and welfare concerns may be standardized and followed for optimum production performance in broiler operation.

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