Impact of Light on Poultry

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Introduction

• What is light?

• Impact of lighting on raising poultry
  – Impacts biological rhythms
  – Impacts physiology: growth, behavior & reproduction

• Important light/lighting characteristics
  – Color
  – Brightness
  – Duration
Light

• Electromagnetic waves (radiation)
  – Visible light small part of full light spectrum
• Visible light (optical radiation)
  ~380 – 780 nanometers (nm)
  Differently perceived by humans and chickens
How Chickens “See” Light

- Two main ways light signals the brain in birds
  - Eyes
  - Extra-retinal receptors = important endocrine glands
    (glands that secret hormones directly into the blood)
Avian Vision

• Chickens have large, highly sensitive eyes
• Flattened shape of eyes increase visual acuity
• Birds have a higher sensitivity than humans
• Rods and cones are structures found in retina
  – More rods than cones = low light vision
  – Cones used for daylight & color vision
Extra-Retinal Light Receptors

Endocrine Glands

- Pineal Gland
- Hypothalamus
- Effect Behavior, Growth & Reproduction
Pathways of Light Reception Effecting Endocrine System
Endocrine Glands

- Light penetrates through the top of skull & stimulates pineal gland & hypothalamus
- Pineal gland light’s sensitivity is used to regulate
  - Daily behavior cycles
- Hypothalamus
  - Regulates broiler metabolism & reproduction
Important Light Characteristics

- Color (wavelength)
- Brightness (intensity)
- Duration (photoperiod)
Color of Light

- Color = wavelength of light
- Poultry have different sensitivity to different colors
  - Poultry perceive light & color differently than humans
  - Unlike humans, birds are sensitive to ultra violet (UV) light
  - Poultry have greater sensitivity to multiple regions of visible light
  - Therefore perceive light from some bulbs as brighter than other bulbs (of same lumens), and more intensely than humans
Impact of Color on Broilers

• Studies using monochromatic light demonstrated superior growth for broilers given blue or green light
  – Some studies suggest broilers are less active under blue or green light than under red or white light
  – Yellow-red color may ↑ activity

• Field performance under different commercial colored lamps have not yielded significant differences yet
  – 2700-3000 vs 4000-5000 K lamps continue to be tested but no clear winners
  – Still opportunities for improvement = LEDs and dimming
Brightness = Intensity

- Foot candles (fc) or lux (1 lx = 0.09 fc)
- Lumen = std. measure of light bulb outputs
- On average, chicken (37%), duck (30%), and turkey (16%) more sensitive to light than in humans
Light Intensity

Impacts rhythms of feeding behavior

• Higher levels are used to stimulate chicks to be more active, eat and drink more after placement

• Minimum level required to:
  • Stimulate pineal gland & hypothalamus
  • Consideration for growers working in houses
Endocrine Light Stimulation

• Light intensity must be strong enough to penetrate skull & cranial tissues to reach pineal gland & hypothalamus
  – primarily by longer wavelengths = orange-red
    • large proportion of full-spectrum white light/incandescent output
  – retinal tissue in the eye plays important role in circadian rhythm
    • allows feedback at very low light levels (~0.1-.3 fc)
Light Stimulation

Optic nerve

Hypothalamus

Pineal Gland

Growth, metabolism & gonadal development

Circadian rhythm, metabolism & stress

Growth, metabolism & gonadal development
Pineal Gland

Presence or absence of light utilized by pineal to:

- Function as pacemaker for circadian rhythm
  - 24 hour cycle = active day & inactive night
- Controls melatonin hormone = dark regulated
  - Impacts night time body temperature
  - Involved in sleep regulation
  - May impact stress levels & immunity
Minimum Light Intensities

- Research indicates there are minimum thresholds for light intensity
- Management/performance guides recommend
  - 2-5 ftc (20-55 lx) for starting chicks
  - gradually reducing down to 0.1 fc (1 lx) for older broilers
  - table egg layers require 0.5-1 fc (5-10 lx)
  - broiler breeders require 1.5-4 fc (17-45 lx) for fertile egg production
- Uniform light pattern important when choosing bulb design
Duration = Photoperiod

- **Period of illumination = day length/artificial lighting**
  - Daily light/darkness cycle strongest environmental stimulus for timing of behavior
    - Impacting feeding, drinking & sleep behavior
- Impacts hypothalamus
- Lighting programs can impact broiler performance
Hypothalamus

• Sensitive to photoperiod
• Regulates pituitary gland which regulates
  – Growth hormone
  – Thyroid: key controller of metabolism & body temperature
  – Gonadal development = egg & sperm production
    • Chickens are long day breeders
Broiler Lighting Programs

• Conventional = continuous or near-continuous 23L:1D
  – Studies showed heritage lines of broilers responded \( \uparrow \) growth
  – Modern strains respond differently = \( \downarrow \) growth

• Short daylength followed by long day
  – 6L:19D to 21 days; 23L:1D remainder
  – Better liveability and feed efficiency

• Intermittent = multiple cycles of 1L:3D, 2L:4D
  – Better feed efficiency, reduced activity
  – Suggested better use of nutrients because more “meal-feeding”

Commercial programs combine photoperiod & dimming
## Impact of Different Lighting Programs

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Conventional 23L:1D*</th>
<th>Short Day 6L to 21 days 23L at 22 days to market*</th>
<th>Intermittent*</th>
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</thead>
<tbody>
<tr>
<td>Feed Intake</td>
<td>100</td>
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<td>96</td>
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<tr>
<td>Body Weight</td>
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<td>100</td>
<td>101</td>
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<tr>
<td>Feed Efficiency**</td>
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<td>Liveability</td>
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<td>105</td>
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<td>Leg problems</td>
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<td>Reduced</td>
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<tr>
<td>Ascites</td>
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<tr>
<td>Light proofing house recomended</td>
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<td>preferred</td>
</tr>
</tbody>
</table>

*No dimming (no change in light intensity)

**Higher feed efficiency = lower feed conversion
Summary

Combining lighting characteristics = greater impact

- Lighting programs combine photoperiod & dimming (intensity) to impact broiler behavior, performance & welfare
- Impact of color still being studied
- When purchasing bulbs consider
  - Need minimum output levels & uniformity
  - Dimming performance
Questions?

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