Lighting Pullets and Layers

March 20, 2014

Ian Rubinoff, DVM, MPH
Hy-Line International
Technical Services Veterinarian
Outline

- Understanding poultry lighting
- Setting up a lighting program
- A guide to different bulbs
Basic Concepts

Light

Portion of the Electromagnetic Spectrum
Radiation

Ultra Violet (UV)

Visible

Infra red (IR)

Light Environment:

Duration → e.i., Photoperiod, Day length

Luminance → e.i., Intensity

Wavelength → e.i., Color
Electromagnetic spectrum

Penetrates Earth's Atmosphere?

Radiation Type
- Radio: $10^3$
- Microwave: $10^{-2}$
- Infrared: $10^{-5}$
- Visible: $0.5 \times 10^{-6}$
- Ultraviolet: $10^{-8}$
- X-ray: $10^{-10}$
- Gamma ray: $10^{-12}$

Approximate Scale of Wavelength
- Buildings
- Humans
- Butterflies
- Needle Point Protozoans
- Molecules
- Atoms
- Atomic Nuclei

Frequency (Hz)
- $10^4$
- $10^8$
- $10^{12}$
- $10^{15}$
- $10^{16}$
- $10^{18}$
- $10^{20}$

Temperature of objects at which this radiation is the most intense wavelength emitted
- $1 \text{ K} (-272 \degree \text{C})$
- $100 \text{ K} (-173 \degree \text{C})$
- $10,000 \text{ K} (9,727 \degree \text{C})$
- $10,000,000 \text{ K} \sim 10,000,000 \degree \text{C}$
Poultry sight is sharp and more sensitive to light changes in intensity & wavelength
# Intensity, Luminance:

<table>
<thead>
<tr>
<th>Luminous Intensity</th>
<th>Candela (candle)</th>
<th>Cd=lm.sr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminous Flux</td>
<td>Lumen</td>
<td>Lm=cd.sr</td>
</tr>
<tr>
<td>Illuminance Power</td>
<td>Lux</td>
<td>Lx=lm/m²</td>
</tr>
</tbody>
</table>

sr = steradian; unit to describe angles in tridimensional space

Fotocandle Meter

Light spectrometer
Intensity, Luminance:

1 Lux = 1 Lumen in 1 m²

Perception for humans is not the same as for birds.
Color rendering index (CRI)
Chromaticity is a method to measure the relative warmness or coolness of light. Expressed in degrees of Kelvin, it was originally developed for incandescent lights.

- >4000K - cool
- 3500 – 3600 K – neutral and balanced
- <3000K - warm
Chromaticity

2800K Incandescent house lamp

5000K fluorescent

Mercury energy spikes
Poultry biology

Reception:

1. Retinal →
   - Cone photoreceptors
   - Visual perception
   - Dopamine & UV-A ↔ melatonin

2a. Pineal → “Soul gland”
   - Photoreceptors (>4 lux)
   - Circadian clock: serotonin and melatonin

2b. Hypothalamic → Sexual Maturity
   - Deep encephalic photoreceptor
   - Sexual hormones
• **Basic Physiological effects of light:**

1. Facilitate sight →
   - *Food search*

1. Stimulate Internal Cycles →
   - *Circadian- day length changes*

2. Initiate and regulate hormone release →
   - *Metabolic regulation: fat & muscle deposition*
   - *Reproduction*
   - *Calcium and phosphorus and bone formation*
Poultry physiology

- **Wavelength differences**
  - Ultraviolet A-B light
    - Vitamin D conversion, calcium and phosphorus metabolism, bone formation, immune system, blood pressure and circulation, muscle development

- **Visual light**
  - Birds have 4 types of single-cone photoreceptors and tetra-chromatic color vision
  - A 5th single-cone is luminance based for motion detection

- **Infrared light**
  - Perceived as heat
Light is Responsible for Wild Bird’s Seasonality

- **Spring**
  - Day length & Intensity $\uparrow$
  - Food Supply $\uparrow$
  - Reproduction $\uparrow$ $\square$ LAY

- **Summer**
  - Intensity Heat, $T \uparrow$
  - Brooding $\neq$ LAY

- **Fall**
  - Day length & Intensity $\downarrow$
  - Food Supply $\downarrow$
  - PULLETS HATCH

- **Winter**
  - Mature Body Size $\uparrow$
  - Day length & Intensity $\uparrow$
  - Onset Sexual Maturity
Modern Layer Production Mimics Nature to Trick Seasonality

Pullet

Start with \( \uparrow \) light L & I
Step Down:
\( \downarrow \) light L & I

Respect Physiological Rules

Gradually \( \uparrow \) Day length
To Sustain Production

Laying Hen

Light Stimulation:
\( \uparrow \) Photoperiod

Grown Pullet
Physiological Rules: Pullets

- Chicks need intense light to find feed & water
- Chicks need many hours of light to eat & drink
- Chicks do need a rest period
- Week 1: 20 hours of light
- Cycle light and dark periods to stimulate feed & water intake – intermittent lighting
Physiological Rules: Pullets

- **Step Down**: ↓ day length & intensity to mimic fall light pattern
  - ↑ Melatonin secretion: keeps GnRH & LH blocked

- **Stimulation**: ↑ day length to mimic spring
  - ↓ Melatonin secretion: stimulate GnRH & LH secretion

- **Onset ovulation** → Laying phase
Do not increase light intensity or day length until you want to stimulate production

Increase day length by small amount weekly entering into lay helps birds maintain high production peak

Birds continue to grow and mature to 32 weeks. Slow stimulation is critical to the still growing & maturing bird

Decreasing day length for adult birds is a signal to start molting
Plan your lighting program before chicks arrive

Understand impact of light on pullet growth and development

Always wait to light stimulate birds for production until body weight goals are met
Intermittent Lighting Program

Use for the first 7–10 days, then return to regular lighting program

Advantages

- Chicks have normal pattern of rest and activity
- Chick behavior becomes synchronized
- When lights are on, weak chicks are pushed to feed and water by larger chicks
- Can reduce early mortality
Intermittent lighting
<table>
<thead>
<tr>
<th>Weeks of Age</th>
<th>Standard Lighting Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 lux</td>
</tr>
<tr>
<td></td>
<td>20 to 30 lux</td>
</tr>
<tr>
<td>30 lux</td>
<td>W-36: 11 to 12 hours</td>
</tr>
<tr>
<td></td>
<td>Brown: 10 to 11 hours</td>
</tr>
<tr>
<td></td>
<td>Decreasing light</td>
</tr>
<tr>
<td></td>
<td>Constant light</td>
</tr>
<tr>
<td></td>
<td>Increasing light at higher intensity</td>
</tr>
</tbody>
</table>
Different Lighting Programs

- **Slow**
  - Later maturity
  - Heavier body weight
  - Larger first egg size

- **Moderate**
  - Standard lighting program

- **Rapid**
  - Earlier maturity
  - Lighter body weights
  - More early eggs

**Hours of Light**

**Age (week)**
Sexual maturity

Day

W36

W98

HYB

Slow  Moderate  Rapid
Egg weight W-36

- Egg weight (g):
  - First 3 weeks: 3.3
  - 26 weeks: 1.4
  - 36 weeks: 1.5
  - 46 weeks: 1.4
  - 56 weeks: 1.5
  - 66 weeks: 1.5

- Varieties:
  - Slow
  - Moderate
  - Rapid

- Initial differences:
  - A
  - B
  - C

- Subsequent differences:
  - a
  - b
  - b
Hy-Line Lighting Program | Brown Commercial | Light grow to light lay | Hatch Date: 04-Feb-14

<table>
<thead>
<tr>
<th>Time of day (hours)</th>
<th>Lights On</th>
<th>Lights Off</th>
<th>Sunrise</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23:00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24:00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Age (weeks)

0:00 02/04/14 03/04/14 04/01/14 04/29/14 05/27/14 06/24/14 07/22/14 08/19/14 09/16/14 36+
Hy-Line Lighting Program | Brown Commercial | Light grow to light lay | Hatch Date: 04-Jul-14

<table>
<thead>
<tr>
<th>Time of day (hours)</th>
<th>Lights On</th>
<th>Lights Off</th>
<th>Sunrise</th>
</tr>
</thead>
</table>

Hatch Dates:

- 07/04/14
- 08/01/14
- 08/29/14
- 09/26/14
- 10/24/14
- 11/21/14
- 12/19/14
- 01/16/15
- 02/13/15

Age (weeks):

- 36+
Dark grow to dark lay

Hy-Line Lighting Program  W-36  Dark grow to dark lay  Hatch Date: 20-Mar-14

03/20/14  04/17/14  05/15/14  06/12/14  07/10/14  08/07/14  09/04/14  10/02/14  10/30/14
Hy-Line Lighting Program  W-36  Dark grow to dark lay  Hatch Date: 20-Mar-14

Time of day (hours)  Age (weeks)

Lights On  Lights Off  Sunrise

Available light bulbs

- Incandescent
- Fluorescent
- Halogen
- LED

**Lighting Facts**

**Per Bulb**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness</td>
<td>450 lumens</td>
</tr>
<tr>
<td>Estimated Yearly</td>
<td>$0.72</td>
</tr>
<tr>
<td>Energy Cost</td>
<td></td>
</tr>
<tr>
<td>Based on 3 hrs/day, 11¢/kWh. Cost depends on rates and use</td>
<td></td>
</tr>
<tr>
<td>Life</td>
<td>22.8 years</td>
</tr>
<tr>
<td>Based on 3 hrs/day</td>
<td></td>
</tr>
<tr>
<td>Light Appearance</td>
<td></td>
</tr>
<tr>
<td>Warm</td>
<td>Cool</td>
</tr>
<tr>
<td>2700 K</td>
<td></td>
</tr>
<tr>
<td>Energy Used</td>
<td>6 watts</td>
</tr>
<tr>
<td>Bulb</td>
<td>Advantages</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Incandescent</td>
<td>Inexpensive, good light for poultry, easy to dim, good for use in cold weather</td>
</tr>
<tr>
<td>Compact fluorescent</td>
<td>Becoming more affordable, energy efficient, easily available, medium to long bulb life</td>
</tr>
<tr>
<td>LED</td>
<td>Most energy efficient bulb, very long bulb life, can be made out of durable and waterproof material, one bulb can be changed to different colors</td>
</tr>
</tbody>
</table>
LED lights have a lot of advantages

There is still a learning curve

- Understanding dimming
- Measuring intensity
Dimming LED lights

- Dimmers need to be compatible with specific LED installed
- Incompatible dimmer can cause LED lights to flicker, overheat, or burn out more quickly
- Work with LED manufacturer to ensure you have the correct dimmer installed
Traditional light meters cannot be used to measure LED lights accurately in a poultry house.

Most light meters are calibrated for visible light at a "white" color temperature, usually ~2800K and most closely associated with ~550-560nm wavelengths.

The spectral response of most sensors and filters are designed to meet the CIE photopic/Human Eye Response curve.
Measuring light intensity

Lumens are calculated using the efficiency curve’s weighting function. Two lights with the same radiant flux but producing light at different wavelengths, therefore, have different measured lumens.

1 watt green light at 555 nm = 683 lumens
1 watt blue light at 480 nm = 68 lumens

Courtesy of Philips
Measuring light intensity

Spectral profile of blue LED light source at 460 nm

Visible wavelengths excluded from measurement of luminous flux

Courtesy of Philips
LED light, though mixed to achieve "white", is discrete monochromatic wavelengths combining Red (700-640nm), Green (550-520nm) and Blue (480-450nm).

The result can be a range of "white" light correlated color temperature (CCT) from 10,000K to 2600K.

Due to the sensor and filter designs there is a significant roll-off of the amount of light that is measured above or below the nominal human eye response, again 550-560nm.