Should We Pay Attention to Photoperiod Manipulation in Dairy Heifer Calves as We Have Done for the Dairy Milking Herd?

Photoperiod (PHP), the amount of light an animal is exposed to in a 24-hr period, can have a profound impact on a dairy operation. PHP response starts when light stimulates photoreceptors in the eye. These in turn relay signals to the pineal gland. This gland secretes a number of hormones including indoleamine melatonin, which is responsible for mediating PHP responses. During light exposure, melatonin levels fall. When it's dark, melatonin rises. The dark phase is critical to allow for PHP responsiveness to continue.

Measuring Light Intensity

Light is measured as Foot Candles (lumens/ square meter) or Lux (lumens/ square foot). Dual range light meters are available to read either unit. There are 10.76 Lux (lx) in 1 Foot Candle (ftc).

Cattle respond to light intensities as low as 5 Lux (about 0.5 Foot Candle). The relative ratio of light to dark determines the day length PHP response as perceived by the animal. Long days are usually caused by a photosensitive response between 14 and 16 hrs of light after the end of a dark period which in turn is perceived as a short day. The hormonal effects of PHP, as mediated by melatonin, can cause important physiological changes in growth, reproduction, and lactation *(Dahl and others, 2000).*

Day length Changes within a Year

Annual day length changes provide light patterns that stimulate photoperiod responses naturally. Knowledge of long and short days by season provides a base to understand potential months in which supplemental light will be needed to maintain photoperiod responses. Table 1 summarizes the changes in day length between sunrise and sunset on the first day of each month in Minneapolis, Minnesota. These values are typical of northern US climates in the central time zone.

Table 1.

Day lengths for Minneapolis, MN in 2004[a]

Month	Day length on the First of the Month
January	8 hr 50 min
February	9 hr 47 min
March	11 hr 08 min
April	12 hr 47 min
May	14 hr 16 min
June	15 hr 24 min
July	15 hr 33 min
August	14 hr 43 min
September	13 hr 16 min
October	11 hr 40 min
November	10 hr 06 min
December	9 hr 02 min

[a]Adapted from ***www.sunrisesunset.com/calendar.as***

Overview of Recommendations for Lactating Cows, Pre-calving Heifers and Dry Cows

After a four-week adjustment to a 16L:8D pattern (16 hrs of light and 8 hrs of darkness), cows will respond with an average of 5 lb. (2.3 kg) extra milk/cow daily (8% response typical). The cyclic pattern of melatonin concentrations influences hormones such as prolactin (PRL) and insulin-like-growth factor-1 (IGF-1). The IGF-1 changes are critical to increases of milk yield. Under a 16L:8D pattern, cows produce more milk and also increase feed consumption. In a continuous 24L:0D pattern, cows will not differentiate day length and will go back to a short-day response mode.

Types of Lighting

PHP responses have been seen with fluorescent, metal halide, and high pressure sodium (HPS) lighting. For cows, 15 ftc (162 lx) 3 feet (1m) from the floor of the stall is recommended. This allows for some variability with burned-out and dirty lamps. The dark phase should be less than 5 ftc. Other considerations for the productivity of the dairy herd concern first-calf heifers in the last trimester of pregnancy and dry cows. These animals should be exposed to short-day PHP (e.g., 8L:16D) during the last 60 days of gestation followed by natural PHP or controlled 16L:8 D PHP during lactation for a milk production response. There is also evidence this cycle has a positive influence on immune function *(Dahl and Petitclerc, 2003; Dahl, 2004*).

What does the research tell us about long vs. short day length patterns as related to heifer calves?

When discussing PHP manipulation in calves, it's important to recognize that many other variables (including calf comfort, nutrition and environmental interactions) will influence the magnitude of the PHP response. Light intensity will also affect frequency of resting and activity phases plus consistency of social behavior such as grooming, licking, feeding and drinking patterns. When lighting is considered for calf housing, it should have color rendition index (CRI) of >80. Incan-descent, halogen, fluorescent, and metal-halide lamps have been suggested summarized in Table 2 below.

Pre-weaning Example

There is little information for pre-weaned calves available. In a Canadian study, Holstein heifer calves were fed 1.1 gal of whole milk daily and offered calf starter. Calves were subject to either 10 hrs or 18 hrs of continuous light (650 lx or 60.4 ftc) from birth to 8 weeks of age. Those given extended lighting had a greater overall gain of 18 lbs. Daily calf starter intake was up 0.6 lb (0.27 kg) and daily water intake increased by 2.4 lb (1.1 kg) per calf (*Osborne and others, 2002).*

Table 2. Characteristics of Light Sources – select CRI > 80; avoid high-pressure sodium and mercury vapor lamps (adapted from Kammel and Holmes, 2003)

Lamp Type	Lamp Size, Watt	Color Rendition Index (CRI)	Efficiency, Lumens/Watt	Lamp Hours
Incandescent	60-200	100	15-20	750-1,000
Halogen	50-150	100	18-25	2,000-3,000
Fluorescent	32-95	70-95	81-98	15,000-20,000
Mercury Vapor	50-250	20-60	40-50	16,000-24,000
Metal Halide	100-250	60-80	80-92	7,500-10,000
High-Pressure Sodium	100-250	20-80	90-110	15,000-24,000

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Post-weaning Examples

PHP responses in dairy heifers exposed to longer day length lighting patterns in fall and winter months have been inconsistent. Michigan work has shown improved body weight gain and feed intake responses by pre-pubertal dairy heifers between November and March with 16L:8D (104 lx; 9.7 ftc) compared to 24L:0D (116 lx; 10.8 ftc), or natural light (112 lx; 10.4 ftc). The light intensities were taken at heifer eye level. This gain response was mostly protein accretion. Short days tend to cause deposition of fat, but dietary energy, heifer size and age seem to be important factors.

Pre-pubertal 3-month-old dairy heifers exposed to 16L:8D through puberty resulted in a continued growth response and advanced onset of puberty. Prolactin (PRL) is proposed as a mediator in PHP induced growth changes. Light intensities of 200 to 600 lx (18.6 to 55.8 ftc) applied for 16 hrs are effective in greater PRL levels. Light intensity of at least 100 lx (9.3 ftc) seems to be necessary for initiation of PHP responses. Pre-pubertal 343 lb (156 kg) dairy heifers in Ireland fed in natural light from 8 hrs 27 min (November) to 11 hrs 42 min (March) had 15% lower gains than those supplemented with an additional 3 to 8 hrs of 600 lx (56 ftc) light. Gain response by heavy dairy heifers (759 lb./345 kg) averaged 6%. *(Peters and others, 1980; Tucker and other, 1984; Zinn and others, 1986; Enright and others, 1995).*

Bottom-line:

From the middle of October to the first part of March in the upper Midwest, the natural light patterns are such that supplemental light to 16 hrs a day seems to be the most beneficial for growth of pre- and post-weaned calves — as long as there is an 8-hr dark period to stimulate the PHP response. Application of 16-hr light for pre-pubertal heifers should be continued through puberty. Inconsistent PHP response occurs when initiating the 16-hr light and 8-hr dark patterns to post pubertal heifers.

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