

## THE EFFECT OF SUPPLEMENTAL LIGHT ON MILK PRODUCTION IN HOLSTEIN DAIRY COWS

### EFFECTUL SUPPLEMENTĂRII CU LUMINĂ ASUPRA PRODUCȚIEI DE LAPTE LA VACILE HOLSTEIN

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*20 multiparous cows were utilized to investigate effect of supplemental light on milk production. Cows were randomly assigned to one of two treatments (n=10): a) 10-13 hours of light and 14-11 hours of darkness/d natural light -NL group; b) 17 hours of light (natural light + supplemental light) -SL group. Supplemental lighting of 350 lx at eye level was provided by fluorescent lamps, controlled by an automatic timer. Multiparous cows in SL group produced more fat corrected milk (FMC) than multiparous cows in NL group. The efficiency of production in dairy cows can be enhanced by the photoperiod manipulation and thus provide another management tool for dairy producers to enhance productivity.*

**Keywords:** *photoperiod, milk yield, supplemental light*

#### Introduction

A number of methods consistently increase milk yield in dairy cows during an established lactation. These include administration of exogenous bovine somatotropin hormone (bST), increased frequency of milking, a long daily photoperiod or combination of these methods. Increased photoperiod has long been used to enhance growth and production in domestic species. With regard to lactation increasing light exposure from 12 hours of light/day (d) short day photoperiod to 16 or 18 hours light/day photoperiod enhance milk production. Observation that long-day photoperiod increased circulating prolactin (PRL) in a number of species promoted investigation of the effects of photoperiod on milk yield. Different laboratories across North America and Europe, ranging in latitudes from 39<sup>0</sup>N to 62<sup>0</sup>N, have confirmed that long-day photoperiod increases milk production (Table 1).

Table 1

Studies reporting effects of supplemental lighting on milk yield  
in lactating cows (Dahl et al, 1999)

| Authors                  | Lactation<br>(latitude)        | Light<br>(type) | Responses to long-day period |          |                 |
|--------------------------|--------------------------------|-----------------|------------------------------|----------|-----------------|
|                          |                                |                 | Milk yield<br>increase/kg/d  | Fat %    | DMI<br>increase |
| Peters et al             | Michigan<br>42 <sup>0</sup> N  | Fluorescent     | 2.0                          | NC       | ---             |
| Peters et al             | Michigan<br>42 <sup>0</sup> N  | Fluorescent     | 1.4                          | NC       | 6.1%            |
| Marcek and<br>Swanson    | Oregon<br>45 <sup>0</sup> N    | Sodium<br>vapor | 1.8                          | Variable | ----            |
| Stanisiewski<br>et al    | Michigan<br>42 <sup>0</sup> N  | Fluorescent     | 2.2                          | 0.16     | ----            |
| Bilodeau<br>et al        | Quebec<br>47 <sup>0</sup> N    | Fluorescent     | 2.0                          | NC       | 4 %             |
| Evans and<br>Hacker      | Ontario<br>43 <sup>0</sup> N   | Fluorescent     | 2.8                          | NC       | NC              |
| Philips and<br>Schofield | Wales<br>53 <sup>0</sup> N     | Fluorescent     | 3.3                          | 0.18     | NC              |
| Dahl et al               | Maryland<br>39 <sup>0</sup> N  | Metal<br>halide | 2.2                          | NC       | NC              |
| Reksen<br>et al          | Norway<br>60-62 <sup>0</sup> N | Fluorescent     | 0.5                          | ---      | ---             |
| Miller et al             | Maryland<br>39 <sup>0</sup> N  | Metal<br>halide | 1.9                          | NC       | 3.5%            |

NC=no change, arrow indicates direction of change

The endocrine mechanism under lying the response, how ever is not understood (Dahl, 1999). Because of the galactopoietics role of PRL in a number of species it would appear to be a logical mediator of the photoperiodic effect on lactation in cows but is not supported by the evidence available. A second hormone possible related to the galactopoietics effects of long days is growth hormone (GH). It is well established that increased circulating concentrations of GH, either exogenously (Banman et al cited by Dahl, 1999) or endogenously (Dahl et al, 1991) increases milk yield in lactating cows. However, there is little evidence that photoperiod influences GH secretion in cattle.

For seasonal breeders such as sheep and horses, entry and egress from the breeding season can be timed through appropriate manipulation of photoperiod. Although

cattle are not seasonal breeders in the strict sense of distinct season of reproductive activity and inactivity there is evidence of seasonal bias in bovine reproduction. For example return to estrous cycle is longer in cows that calve in winter relative to those calving in summer. Timing of puberty is also influenced by season and birth. Cattle exposed to 18 hours of light and 6 hours darkness has greater luteinizing hormone response to estradiol than those heifers on 8 hours of light and 16 hours darkness (Hansen et al 1985, cited by Dahl et al, 2000). With regard to mammary growth, long day increase parenchyma tissue and limit fat in heifers relative to animals on short days (Petitclerc et al, 1984 cited by Dahl et al, 2000).

Integration of photoperiod into the management scheme for an entire lactation cycle has not been fully developed.

The objectives of our study was to determine whether long day photoperiod (LDPP) is an effective management practice that could be used to increase milk production on high production dairy.

### **Materials and Methods**

During January and April 2007, 20 lactating Holstein cows multiparous at >60 days in milk (DIM) were balanced for uniformity according to DIM and milk yield. Cows were randomly assigned to one of two treatments (n=10, per treatment):

- 10-13 hours of light and 14-11 hours of darkness/d natural light -NL group
- 17 hours of light (natural light + supplemental light) -SLgroup

This study consisted of ten 12 day measurement periods including a 12 days pretreatment adjustment period and a 12 days post treatment period for a total duration of 120 days. Cows were housed at the Agricultural Research & Development Station Simnic –Craiova, Romania placed at 44<sup>0</sup>19' northern latitude and 23<sup>0</sup>48' eastern longitude in a closed tie-stall barn.

Supplemental lighting of 350 lx at eye level was provided by fluorescent lamps, controlled by an automatic timer. Lights were turned on at 05.00 h and off at 22.00 h for SL group. Cows were milked at 06.00 and 16.00 h.

Cows were fed a total mixed ration to provide 100% of the nutrient requirements (table 2). Milk yield was summed daily and milk was sampled at each 12 days period (a.m. and p.m. combined) for composition analysis. Fat, non fat solids and protein were measured by ECOMILK Ultrasonic milk analyzer (EON Trading). SCC was measured by Somascope MK II (Delta Instruments). Net energy balance (NEB) was calculated as:

NEB=Net energy intake-Net energy lactation(NE<sub>L</sub>)-Net energy maintenance(NEM)

where: NE<sub>L</sub>=milk (kilograms) x 0.3512+0.0962 x fat percentage

and NEM= 0.08 Mcal/kg<sup>0.75</sup> x BW<sup>0.75</sup> (body weight)

Cows were weighed every 12 days period. Feed refusals were recorded and data were adjusted for DMI. Feed samples were collected and analyzed for composition. Analyses of data were performed.

Table 2

## Ingredients and composition of diet

| Ingredients (% DMI basis)         | Post partum |
|-----------------------------------|-------------|
| Corn silage                       | 30.9        |
| Crops hay                         | 15.5        |
| Grass hay                         | -           |
| Alfalfa hay                       | 8.6         |
| Ground corn                       | 24.6        |
| Soy bean meal (44.5% CP)          | 11.4        |
| Sun flower meal                   | 5.6         |
| Sodium bicarbonate                | 0.5         |
| Mineral and vitamin mix           | 2.9         |
| Chemical analyses (%) of the diet |             |
| CP                                | 16.4        |
| NDF                               | 34.3        |
| DDF                               | 22.0        |
| NEL                               | 1.63        |
| Co                                | 1.07        |
| P                                 | 0.49        |
| Mg                                | 0.32        |
| K                                 | 1.40        |

**Results and Discussion**

Treatment with SL increased FCM by 1.9 kg/d relative to NL treatment (Table 3)

Table 3

Effect of photoperiod on milk yield, milk composition, DMI, NEB and BW

| Item                      | NL   | SL   | Differences (SL-NL) |
|---------------------------|------|------|---------------------|
| Milk kg/d                 | 24.8 | 27.0 | +2.2                |
| 3.5% FCM kg               | 29.7 | 31.6 | +1.9                |
| Protein %                 | 3.3  | 3.2  | -0.1                |
| Fat %                     | 4.2  | 4.1  | -0.1                |
| SCC x 10 <sup>3</sup> /ml | 340  | 230  | -80                 |
| DMI (kg)                  | 21.8 | 22.6 | +0.8                |
| NEB (Mcal/d)              | 10.0 | 10.1 | +0.1                |
| BW (kg)                   | 620  | 625  | +5                  |

The 1.9 kg of FCM production response observed is consistent with other researchers (Peters et al, 1978, 1981; Miller et al 1999; Dahl et al, 2000; Vanbaale et al, 2005).

Treatment with SL increased DMI with 0.8 Mcal/d and body weight with 0.5 kg in SL group relative with NL group.

Long days increased milk yield relative to natural light and this response became significant after 36 days. Milk composition was little affected by SL.

Component yields increased parallel with milk yields. Thus is possible to use long day photoperiod to achieve greater milk yields.

### **Conclusions**

Exposure to long days increases milk production in dairy cows with little effect on milk composition. Cows increase intake to meet the increased energy demand. Photoperiod manipulation is impractical for those that use three times milking.

The efficiency of production in dairy cows can be enhanced by the photoperiod manipulation and thus provide another management tool dairy producers to enhance productivity and profit ability. It is also of interest to consider the photoperiod treatment in the context of other management practices.

Because no physiological measurements were obtained it is not known what contributed to the increase in milk yield but increased lighting is an effective management practice that can be used to improve milk production of high producing dairy cows.

### **References**

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