

# PHOTOPERIOD AND HEAT STRESS INFLUENCE ON LACTATING SOW PERFORMANCE AND PHOTOPERIOD EFFECTS ON NURSERY PIG PERFORMANCE

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## ABSTRACT

Three experiments were conducted to evaluate sow and piglet productivity under extended photoperiod. In Exp. 1, 98 crossbred, lactating sows were housed in one of four treatments: thermoneutral air temperature (23.6°C) in either (h of light:dark) 1:23 or 16:8 photoperiods, or heat stress (30.4°C) in either 1:23 or 16:8 photoperiods. Heat stress reduced ( $P < .05$ ) sow feed intake, piglet mortality and piglet weaning weight and increased ( $P < .01$ ) sow lactation weight loss. Number of pigs weaned per litter was increased ( $P < .01$ ) when sows were heat-stressed. Extended photoperiod reduced ( $P > .05$ ) time for sows to rebreed postweaning by 4 d. The interaction between air temperature and photoperiod was significant only for sow lactation weight loss. Heat stress increased sow lactation weight loss, but this effect was more severe in the 1:23 than in the 16:8 photoperiod. Experiments 2 and 3 examined the effects of 1:23 or 16:8 photoperiods on nursery pig performance when pigs were weaned from sows experiencing 1:23 (Exp. 3) or 16:8 (Exp. 2) photoperiods. In both nursery studies, photoperiod did not influence ( $P > .10$ ) postweaning pig mortality, feed intake, weight gain or gain:feed ratio. In conclusion, extended photoperiod reduced days to return to estrus and reduced sow lactation weight loss, especially during heat stress. No benefits in preweaning or postweaning piglet weight or survival were observed by use of extended photoperiod. (Key Words: Pigs, Heat Stress, Photoperiod, Lactation.)

## Introduction

Baby pig survival and sow-litter lactation performance are economically important traits influenced largely by the environment. Summer-time reduction in sow-litter productivity is well documented on commercial farms (Cox et al., 1983). In a laboratory setting, heat stress or warm air temperature explains much of this observed summertime suppression in sow feed intake and piglet weight gains (Stansbury et al., 1987).

Recently, extended photoperiods (such as 16 h of light/day) have been adopted in some commercial confinement units to enhance piglet survival and weaning weight. Researchers in Georgia and Kansas have documented enhanced piglet survival and weaning weight by use of 16:8 (h of light:h of dark) compared with only enough light to feed and care for sows and piglets (Mabry et al., 1982; Stevenson et al., 1983). The two research groups disagreed on the effects of extended photoperiod on sow postweaning return to estrus; Stevenson et al. (1983) found that extended photoperiod hastened estrus.

In a natural setting, long days (e.g., 16:8) would be experienced along with heat stress. Therefore, in the first experiment, we examined the potential interactive effects of photoperiod and warm air temperature on sow-litter performance and on sow postweaning return to estrus. In subsequent studies we sought to determine the effects of extended postweaning photoperiod on weaned pig performance using pigs from

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thermoneutral farrowing rooms with either 1:23 or 16:8 photoperiods. In Exp. 2 and 3, we explored whether piglets required a postweaning photoperiod similar to the photoperiod they received during the lactation stage to obtain maximum performance.

#### Methods

**General.** Sows were derived from a four-breed rotational cross using Yorkshire, Landrace, Hampshire and Duroc breeds. Sows were fed 2.0 kg/d of a fortified sorghum-soybean meal diet (13% CP) during gestation. Sows were moved to the confined, mechanically ventilated farrowing barn at d 109 of pregnancy. Once in the farrowing barn, sows had ad libitum access to a 14% CP sorghum-soybean meal diet. Weaning pigs had ad libitum access to a 19% CP sorghum-soybean meal diet and water. Lactation periods averaged 28 d. Farrowing crates were 1.5 x 2.2 m. Piglets were provided creep feed beginning at 14 d of age.

Two floor types were used: plastic-coated expanded metal (44 litters) and partially slotted concrete (54 litters). Floor types were described in detail by Stansbury et al. (1987). Air temperature was controlled by thermostats and gas-fired furnaces.

**Light Survey.** Fluorescent tubes provided the majority of artificial light in the farrowing and nursery barns. One light fixture with two 2.4-m tubes was above each farrowing crate. In addition, heat lamps in the farrowing barn and sunlight entering the fan area provided light. Therefore, we determined the quality and quantity of light as another measure of the photic environment (besides the L:D cycle).

A light meter<sup>3</sup> was used to determine the light intensity at sow level (3 m above the floor). Because visible light may be a combination of light from several sources (bulbs and sun), the photic spectra also was determined. A radiometric filter was attached to a Photic Research Model 301 spectra photometer to measure the photic intensity at a range of light wavelengths.

**Experiment 1. Photoperiod and Heat Stress.** A total of 98 crossbred gilts and sows were used

in this study. Sows were in one of two farrowing barns and were submitted to one of the following factorially arranged treatments: 23.6°C and 1:23 photoperiod; 23.6°C and 16:8; 30.3°C and 1:23; 30.3°C and 16:8. Air temperature was continually recorded by a floor-level, calibrated hygrothermograph. The heat-stress air temperature (30.3°C) was maintained at 27.5°C until all gilts or sows farrowed, then air temperature was raised to 30.3°C. This procedure prevented gilts and sows from dying from heat stress during parturition (which occurred in our earlier work).

This study was conducted during the winter and spring months. Thus, gilts and sows were not acclimatized to warm temperatures and they had experienced natural short-day photoperiods during gestation.

The experimental design was a completely random design with a two x two factorial arrangement of temperature and photoperiod treatments and floor types nested within treatments. Number of piglets alive at 1 d of age and sow parity (gilt vs sow) were included in the model as covariates to assure that these variables were mathematically constant in each treatment at the outset of the study. The statistical model included effects of air temperature, photoperiod, temperature x photoperiod interaction, floor type nested within each factor and the covariates. The residual error term was used to test all effects. The sow-litter was considered the experimental unit.

**Experiments 2 and 3.** Photoperiod in Nursery. Two studies were conducted using 216 weaning pigs to examine the effects of nursery photoperiod when piglets were weaned from sows experiencing short or extended photoperiods.

Sow groups from Exp. 1 were used. Piglets were selected from litters that had experienced thermoneutral air temperatures (23.6°C). In Exp. 2, the previous farrowing barn photoperiod was 16:8, whereas in Exp. 3 the previous photoperiod was 1:23. Six weeks separated Exp. 2 and 3.

During both Exp. 2 and 3, treatments included photoperiods of 1:23 or 16:8. Piglets on different treatments within each experiment were in the same nursery building, with an opaque black plastic sheet dividing the room in half. Because the room was symmetrical, each half of the room contained one gas-fired heater and the same number of power ventilation fans. A particular photoperiod was alternated on a

<sup>3</sup>General Electric, Inc., model 214. Appreciation is expressed to Robert Morris, Dept. of Environ. Health and Safety, Texas Tech Univ., Lubbock, for conducting the light survey.

given side of the room from one experiment to the next. On this and previous pilot work, no side effects on pig performance were noted.

Mortality, feed usage, weight gain and gain:feed ratio were determined during the 28-d postweaning growth period. The statistical model included effects of photoperiod and random error. Data from each experiment were analyzed separately.

#### Results and Discussion

**Light Survey.** Farrowing barns averaged 125 lx at sow level and 350 lx directly under the fluorescent bulbs while overhead lights and heat lamps were on. When heat lamps were on and the overhead lights were off, sows and piglets were provided 35 lx. When all lights were off (as did not occur during the study) light was not detectable at sow level. The lower limit of detectability was less than 10 lx.

We assumed light was from three sources: fluorescent bulbs, heat lamps and sunlight. Therefore, by subtraction, fluorescent lights provided the sows 90 lx, the heat lamp 35 lx and the sunlight near zero light. Of course, the piglets experienced a greater amount of light if they lay directly under the heat bulb.

Weaning pigs experienced about 80 lx. When lights were off, the photic intensity was not detectable.

The spectrum of light experienced by sows and piglets in the farrowing barn is presented in Figure 1. The light spectrum was nearly identical for the nursery (not presented). The range of visible light is from about 4 to 7.5 angstroms. Pigs experienced weaker stimulation in red (note low lx at 7 angstroms in Figure 1) and dark blue to red wavelengths (about 4 to 5 angstroms). The strongest photic stimulation was in the wavelengths (note high lx at 6 angstroms in Figure 1) representing yellow.

Stevenson et al. (1983) reported 27 to 54 lx during dark phases from heat lamps and 32 to 366 lx during the light phase. Their fluorescent tube lights were similar in design and number to ours. Mabry et al. (1983) reported fluorescent light intensities of 400 to 500 lx. Light at 400 to 500 lx is very bright to the human eye and would not be found commonly on commercial farms. Neither of these two previous studies reported the spectra of light in the environment.

The quality of light (i.e., the light spectrum) influences gilt reproduction. Cool white light and daylight were more effective in stimulating early puberty than red light (Wheelhouse and

Hacker, 1982). We know of no such information on the effects of various wavelengths of light on growth and lactation in pigs.

Results of research on photoperiod effects on the growth, survival and reproductive processes of the domestic pig cannot be interpreted effectively until researchers report more details of the photic treatments. Because light bulbs can vary in spectrum of light emitted as well as in light intensity, scientists at different sites are unlikely to have applied the same photic treatments, making interpretation across sites even more difficult.

**Experiment 1. Photoperiod and Heat Stress.** Heat stress depressed sow feed intake by over 13% ( $P = .0001$ ; Table 1). Heat-stressed cows also lost more ( $P < .0001$ ) weight during lactation (Table 1). However, the temperature  $\times$  photoperiod interaction was significant for sow lactation weight loss. Heat stress caused a greater lactation weight loss in the 1:23 photoperiod than in the 16:8 photoperiod. In this respect, extended photoperiod provided a benefit to sows.

Postweaning estrus was hastened by less than .5 d in sows housed in 16:8 compared with 1:23 ( $P = .02$ ). Although this difference was statistically significant, such a small hastening of estrus probably is of little biological or economic importance. Our finding of photoperiod-induced postweaning estrus acceleration is in agreement with research by Stevenson et al. (1983) but was not found by Mabry et al. (1983).

Heat stress increased the number of piglets weaned per litter. Because piglets were not heat-stressed at 30°C, this warmer temperature may have provided a benefit to piglets. This benefit of warmer air temperatures may have been expressed in improved piglet survival.

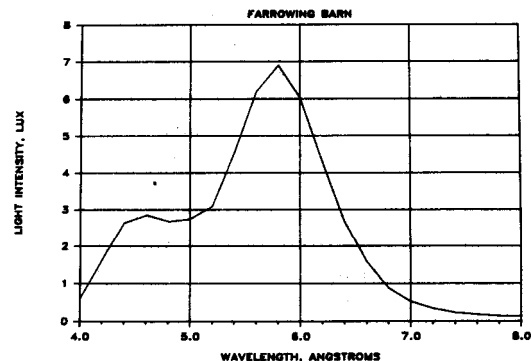


Figure 1. Light spectrum in farrowing barn.

TABLE 1. MEASURES OF SOW AND LITTER PERFORMANCE AT THERMONEUTRAL AND WARM AIR TEMPERATURE IN TWO PHOTOPERIODS (EXP. 1)

Item	1:23 (L:D)		16:8 (L:D)		SE <sub>P</sub>	P values <sup>a</sup>		
	23.6°C	30.3°C	23.6°C	30.3°C		T	P	T × P
<b>Sow measures</b>								
No. of litters	25	19	25	29				
Feed intake, kg/d	6.7	5.5	6.7	6.1	.19	.0001	NS	NS
Lactation wt loss, kg	-4.9	-22.1	-8.8	-13.9	3.0	.0001	NS	.01
Time postweaning to return to estrus, d	4.8	4.9	4.1	4.7	.2	.09	.02	NS
<b>Litter measures</b>								
No. born live	10.0	10.2	10.4	10.9	.52	NS	NS	NS
No. born dead	.7	.9	.8	.7	.27	NS	NS	NS
No. weaned	8.6	9.6	8.9	9.3	.2	.0008	NS	NS
Preweaning mortality, %	15.0	5.6	11.8	8.3	1.6	.0002	NS	.08
Mean weaning wt, kg	7.4	6.9	7.2	6.8	.2	.029	NS	NS
Total litter weaning wt, kg	63.3	65.9	63.5	62.9	2.2	NS	NS	NS
Creep feed intake, kg	.68	1.11	.73	1.27	.4	NS	NS	NS

<sup>a</sup>P-values for effects of temperature (T), photoperiod (P) and their interaction (T × P); NS = not significant (P > .10); SE<sub>P</sub> = pooled SE.

Average piglet weaning weight was suppressed during heat stress. Heat-stressed sows had lower feed intakes, which may have reduced milk production and consequently reduced piglet growth rate.

The lowest piglet mortality rate was found in the heat stress treatment. However, at 30°C, piglet survival was improved (Table 1) but piglet weight gain was suppressed (probably due to reduced sow feed intake and reduced milk production). The ideal farrowing barn environment may be one in which simultaneously the piglet is provided a microenvironment with an air temperature in its thermoneutral zone (but warm enough to cause heat stress to the sow) and the sow is provided a microenvironment with an air temperature in her thermoneutral zone (but cool enough to cause cold stress to the piglets). However, relying on the piglets to choose the heat lamp area as their microenvironment may not prove sufficient. Because piglets spent time away from the heat lamp, cold stress (at 18°C air temperature with a heat lamp) was experienced (Stansbury et al., 1987).

Two suggestions may be made to improve sow and litter productivity. The first is to find ways to attract piglets to the zone-heated area

while air temperature is maintained at a thermoneutral temperature for the sow (23°C). The second possibility is to provide an air temperature (or, more appropriately, an effective environmental temperature) that is warm for the piglets (say 30°C or more) and to provide zone cooling for the sow, such as water drip (McGlone et al., 1988). No method exists to accomplish the first option, and the economic feasibility of the second option has not been demonstrated.

**Experiments 2 and 3. Photoperiod in Nursery.** Listed in Table 2 are results of Exp. 2 and 3. Photoperiods of 1:23 vs 16:8 had no measurable effects on nursery pig survival, weight gain or gain:feed ratio. Means are strikingly similar across treatments within experiments. We therefore concluded that the photoperiods tested had no measurable influence on any economically important measure of pig performance. The reason for lower weight gains and poorer feed conversion in Exp. 3 is not known. This difference could not be statistically analyzed because the experiments were conducted at different times.

Previous studies have documented the effects of various short and long photoperiods

TABLE 2. MEASURES (LEAST SQUARES MEANS) OF NURSERY PIG PRODUCTIVITY IN TWO PHOTOPERIODS (EXP. 2 AND 3)

Item	Exp. 2 <sup>a</sup>			Exp. 3 <sup>b</sup>		
	1:23 (L:D)	16:8 (L:D)	SE <sub>P</sub>	1:23 (L:D)	16:8 (L:D)	SE <sub>P</sub> C
o-14 d						
No. of pens/treatment <sup>a</sup>	9	9		9	9	
Avg daily feed intake, kg/d	.58	.58	.02	.40	.37	.02
Avg daily wt gain, kg/d	.32	.31	.02	.22	.20	.01
Gain:feed ratio	.54	.52	.06	.55	.55	.04
14-28 d						
No. of pens/treatment <sup>a</sup>	9	9		9	9	
Avg daily feed intake, kg/d	1.16	1.14	.03	2.01	2.05	.06
Avg daily wf gain, kg/d	.56	.56	.01	.48	.50	.01
Gain:feed ratio	.48	.49	.05	.24	.24	.05
O-28 d						
No. of pens/treatment <sup>a</sup>	9	9		9	9	
Avg daily feed intake, kg/d	.87	.86	.02	1.20	1.21	.03
Avg daily wt gain, kg/d	.44	.43	.01	.35	.35	.01
Gain:feed ratio	.50	.50	.04	.29	.29	.02

<sup>a</sup> barn photoperiod 16:8.

<sup>b</sup>Farrowing barn photoperiod 1:23.

<sup>c</sup>SE<sub>P</sub> = pooled SE.

<sup>d</sup>Six pigs/pen; 108 pigs/experiment, 216 pigs total; Average initial pig wt was 7.96 kg.

on growing-finishing pig performance. Boars, barrows and gilts from 7 wk to 6 mo of age had similar weight gain and feed efficiency under a variety of photoperiods (Ntunde et al., 1979; Berger et al., 1980).

Therefore, because farrowing, nursery and growing-finishing barn photoperiods did not influence pig performance, pork producers are likely to use light only to feed, observe, handle and care for their pigs. We conclude that nursery pigs showed no benefit from any specific photoperiod we tested.

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