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TECHNICAL NOTE: Initial evaluation of floor cooling on lactating sows under acute heat stress[1]

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ABSTRACT

Our study objectives were to evaluate an acute heat stress protocol for lactating sows and evaluate preliminary estimates of water flow rates required to cool sows. Twelve multiparous sows were provided with a cooling pad built with an aluminum plate surface, high-density polyethylene base, and copper pipes. Treatments were randomly allotted to sows to receive a constant cool water flow of 0.00 (control, n = 5), 0.25 (LO, n = 3), 0.55 (MED, n = 2), or 0.85 (HI, n = 2) L/min for 90 min. The cooling was initiated 1 h after the room reached 35°C. Respiration rates (RR), rectal temperature (RT), and skin temperature (15 cm posterior to the ear) were recorded before the trial, before cooling, and after 90 min of cooling. Water flow rates and inlet and outlet water temperatures were recorded 6 times (every 15 min) to calculate heat removal after cooling initiation. In all 3 replications, treatments were switched randomly among sows. The mean ambient temperature and relative humidity during the trial were 35.3 ± 0.7°C and 57.8 ± 3.1%, respectively. Treatments affected RR and RT after 90 min of cooling. At the end, the mean RR and RT were 132 breaths/min and 39.9°C for the control; 89 breaths/min and 39.5°C for the LO; 71 breaths/min and 39.2°C for the MED; and 31 breaths/min and 39.1°C for the HI treatment ($P < 0.001$ and $P < 0.001$, respectively). Cooling pads with MED and HI water flow rates reduced RR and RT in lactating sows.

Key words: sow, lactation, heat stress, cooling pad

INTRODUCTION

At high environmental temperatures, lactating sows reduce their daily feed intakes and milk production to reduce their internal heat production (Quiniou and Noblet, 1999; Cabezón et al., 2017), which affects piglet growth (Renaudeau and Noblet, 2001). In addition, heat stress negatively affects fertility (Prunier et al., 1997; Knox et al., 2013; Williams et al., 2013). The seasonal decreases in sow and piglet productivity and sow fertility due to heat stress have a substantial economic effect on the pork industry. Heat stress is estimated to cost the United States pork industry over $360 million annually (St-Pierre et al., 2003).

Selection for increased litter size and milk production in current sows has reduced their upper critical temperature to approximately 18°C (Quiniou and Noblet, 1999) and increased their heat production in comparison to past sows (Brown-Brandl et al., 2014; Stinn and Xin, 2014; Cabezón et al., 2017). For sows to achieve their full genetic potential for milk production and minimize BW loss during lactation, some of the excess heat produced must be removed.

Water drip and snout cooling systems in conjunction with increased ventilation rates are currently used to reduce the heat stress of lactating sows (Barbari et al., 2007). Floor cooling improved sow productivity and reproductive performance by removal of sow's excess heat (Silva et al., 2006, 2009; Van Wagenberg et al., 2006) under conditions with maximal daily temperatures of 24 to 29°C. Recently, a cooling pad has been designed to increase the potential removal of excess heat of modern lactating sows in high environmental temperatures (F. A. Cabezón, A. P. Schinckel, and R. M. Stwalley, unpublished data). However, the newly designed cooling pad has not been evaluated with actual lactating sows.

The objectives of this research were (1) to evaluate the effect of an acute heat stress protocol with higher environmental temperatures (35°C) on sow heat stress responses, and (2) to evaluate the effect of different water flow rates through the cooling pad on the estimated amount of heat removal and reduction in the sow's responses to heat stress.

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MATERIALS AND METHODS

Experimental Design

The Purdue Animal Care and Use Committee approved all animal procedures. The experiment was conducted in July 2016 at the swine farrowing facility at Purdue University Animal Science Research farm. The farm is located in a humid continental climate with warm summers (40°29′59″N and 87°00′47″W, with an altitude of 218 m), classified as Dfa (Köppen, 1948).

Twelve multiparous sows (commercial crossbred Yorkshire and Landrace) were housed in individual farrowing crates, and each sow was provided with a cooling pad. The trial was conducted at early lactation when the average lactation length of the sows was 5.3 ± 2.7 d. Treatments were randomly allotted to sows to receive a constant cool water flow of 0.00 (control, n = 5), 0.25 (LO, n = 3), 0.55 (MED, n = 2), or 0.85 (HI, n = 2) L/min for 90 min. The cooling was initiated 1 h after the target room temperature of 35°C was reached. A protocol outline of the trial is presented in Figure 1. The protocol for the 12 sows was repeated 3 times. In each of the 3 replications, treatments assigned to the sows, the experimental unit, were switched randomly. The treatments were allocated such that each treatment was represented in each row of 6 farrowing crates.

Animal Handling

Sows had ad libitum access to a corn and soybean meal–based diet with 5% distillers dried grains and solubles and 3% choice white grease. The diet was formulated to meet or exceed nutrient requirements (0.9% standardized ileal digestible lysine, NRC, 2012). Feed was given twice daily at 0700 and 1500 h. All sows had ad libitum access to water. Piglet processing (ear notching, tail docking, castration, teeth clipping, and supplemental iron injection) was performed during the first 48 h postpartum. Piglet cross fostering was allowed only during the first 48 h after processing. Litter size was standardized to approximately 10 or more piglets per sow (mean = 11.2 ± 1.1). Piglets were provided supplementary heat using one heat lamp per farrowing crate.

Equipment and Installations

The farrowing room had one heater and one fan that worked independently of each other. The heater was set to achieve 35°C once the trial started. The fan (fan and screen opening of 0.41 × 0.41 and 0.48 × 0.46 m, respectively) had 2 operating options (off or 100% speed). The fan was running at 100% speed during the entire trial. The screen opening in the fan was reduced to 50% to maintain the temperature. Temperature, relative humidity, and dew point in the farrowing room were recorded in 5-min intervals, using 2 data loggers (accuracy: ±0.5°C, 3%, and 1.1°C for temperature, relative humidity, and dew point, respectively, EL-USB-2, DATAQ Instruments Inc., Akron, OH). The data loggers were tested under a range of temperatures in comparison to a scientific thermometer. The data loggers were placed 0.7 m from the floor at the sow level and away from water sources.

Each sow was provided with a cooling pad made with an aluminum diamond plate on the top, a high-density polyethylene base, and 8 copper water pipes (Figure 2, F. A. Cabezón, A. P. Schinckel, and R. M. Stwalley, unpublished data). Each cooling pad had an outlet valve to regulate the water flow and an inlet valve to take inlet water samples. Each valve was provided with a hose to collect water in a cup.

Measurements and Parameters Analyzed

Sows were weighed at 3.3 ± 2.8 d after farrowing at an average lactation length of 3.3 ± 2.8 d. Respiration rates (**RR**), rectal temperature (**RT**), and skin temperature (**ST**) were recorded just before the initiation of the trial, before cooling and at the end of the trial (after 90 min of cooling). Respiration rates were recorded as the number of breaths (flank movement) counted in 30 s. Rectal tem-

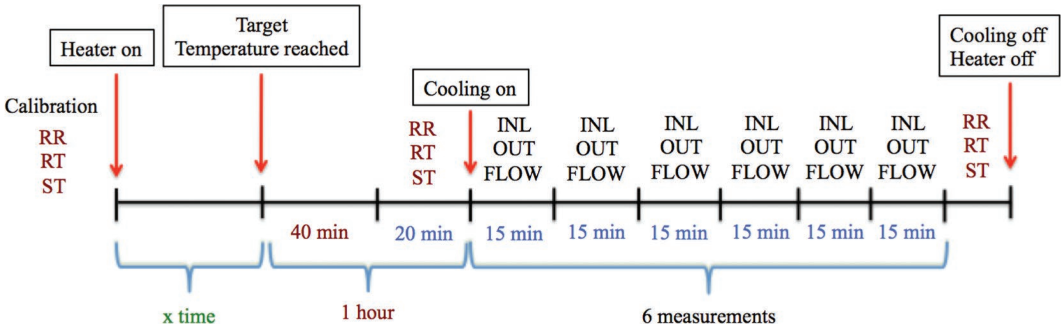

Figure 1. Protocol followed for each replication of the trial. The water flow rates assigned for each sow were calibrated before the trial. The trial started when the heater was turned “on.” Once the target temperature in the room was reached (target temperature = 35°C), the cooling was turned “on” 1 h later. Respiration rates (RR), rectal temperature (RT), and skin temperature (ST) were recorded just before the initiation of the trial, before cooling, and after 90 min of cooling. Heat removal was calculated using the temperature differential between the outlet temperature (OUT) and the inlet temperature (INL), and the water flow rate (FLOW). The INL, OUT, and FLOW were recorded 6 times (every 15 min) during the cooling phase. Color version available online.