Design and feasibility of a novel sprinkler control algorithm for swine heat stress alleviation

Brett C. Ramirez  
*Iowa State University*, bramirez@iastate.edu

Steven J. Hoff  
*Iowa State University*, hoffer@iastate.edu

Jay D. Harmon  
*Iowa State University*, jharmon@iastate.edu

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Effects of increasing space allowance by removing a pig or gate adjustment on finishing pig growth performance.

C. B. Carpenter*, C. J. Holder, M. D. Tokach, J. M. DeRouchey, J. C. Woodworth, R. D. Goodband, and S. S. Dritz, Kansas State University, Manhattan

A total of 256 pigs (PIC 327 × 1050; initially 55.9 kg) were used in a 71-d study to determine the effects of space allowance and pig removal on finishing pig performance. The 4 treatments included: 0.91m²/pig or 0.63m²/pig for the entire study and initially 0.63m²/pig with a gate adjusted or the heaviest pig removed to keep pigs above their predicted minimum space requirement (m² = 0.0336*BW⁰.⁶⁶). Initially, there were 8 pigs/pen and 8 pens/treatment. From d 0 to 28, prior to any space adjustments, ADG was marginally greater (P = 0.076) for pigs provided 0.91m² compared with those provided 0.63m². From d 28 to 71, ADG and ADFI decreased (P = 0.001) when pigs were provided 0.63m² compared with pigs provided 0.91m². Pigs provided increased space by removing pigs had similar performance to those where gates were adjusted; however, pig removal resulted in lower ADFI than pigs allowed 0.91m² throughout the experiment. Overall, pigs allowed 0.91m² had increased (P = 0.001) ADG compared with pigs allowed 0.63m² or either adjusted space treatment. Removing pigs or adjusting gating increased (P = 0.001) ADG compared to those kept at 0.63m²; however, neither treatment had ADG similar to pigs allowed 0.91m². Pigs allowed 0.91m² had greater (P = 0.001) ADFI compared with pigs allowed 0.63m² with adjusted space allowance pigs being intermediate. Feed efficiency was not affected in the cumulative growth periods. In summary, either removing a pig or adjusting the gating as pigs reached the critical k-value influenced growth similarly. Results indicate the performance benefit from removing the heaviest pigs from the pen is primarily from increased space allowance. Pigs provided more space as they reached the space requirement had lower growth than unrestricted pigs indicating the minimum space prediction equation (m² = 0.0336*BW⁰.⁶⁶) doesn’t fully explain pen space effects on pig performance.

Key Words: finishing pig, growth, space

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B. C. Ramirez*, S. J. Hoff, J. D. Harmon, Agricultural and Biosystems Engineering, Iowa State University, Ames.

Pigs have a relatively low capacity to dissipate excess body heat and depend more on reducing metabolic heat production through a reduction in voluntary feed intake in hot conditions, resulting in a growth performance decrease. Effectiveness of current cooling devices (e.g., evaporative coolers or sprinklers) in facilities is governed by the Water Vapor Pressure (WVP) concentration gradient between the air (a function of dry-bulb temperature, tdb; relative humidity, RH; and atmospheric pressure) and saturated WVP at a wet surface. Traditional sprinkler control systems (TSCS) often operate solely on tdb feedback and at fixed “off” intervals to allow dispersed water to evaporate. This control strategy does not account for the WVP concentration gradient; hence, water is wasted and only a limited amount of latent heat can be removed from the animal. Therefore, the objectives were to develop and simulate a novel variable interval sprinkler control system (VISCoS) that dynamically changes the “off” interval based on tdb, RH, and airspeed feedback. A theoretical convective mass transfer model (i.e., evaporation) was developed to estimate water evaporation rate as a function of the thermal environment, surface area, skin temperature, and volume of water applied. A pig’s geometry was assumed a cylinder approximately 30% wet with a 1-mm film of water. The feasibility of implementing VISCoS was evaluated at six locations (AZ, IA, MN, MO, IN, and NC) by simulating water usage for a 1000 hd, mechanically ventilated,
The study objective was to evaluate the effects of post-weaning transport during heat stress (HS) on post-transport piglet health and productivity when dietary antibiotics were removed or replaced with a nutraceutical. Sixty mixed sex piglets from 10 sows (n = 6 piglets/sow) were weaned (18.8 ± 0.8 d of age) and then herded up ramps into one of two simulated transport trailers in thermoneutral (TN; 28.8 ± 0.2°C; n = 30 piglets) or HS (cyclical 32 to 37°C; n = 30 piglets) conditions for 12 h. This procedure is referred to as simulated transport, as in piglets are weaned from the sow, herded down an alley and up a ramp into a trailer, fans simulated air movement, and feed and water were withheld; however, trailer movement was not simulated, only the regrouping, isolation, and duration component. Following the 12-h simulated transport, piglets were unloaded from the trailer, weighed, and then housed individually in TN conditions (28.5 ± 0.1°C; 29.1 ± 0.1% RH) and assigned to one of three dietary treatments balanced by weaning weight, sex, sow, and transport environment. Treatments were dietary antibiotics [A; n = 20 piglets; 5.5 ± 0.2 kg BW; chlortetracycline (400 g/ton) + tiamulin (35 g/ton)], no dietary antibiotics (NA; n = 20 piglets; 5.6 ± 0.2 kg BW), or 0.2% L-glutamine (GLU; n = 20 piglets; 5.6 ± 0.2 kg BW) fed for 14 d. Feed intake (FI), BW, and behaviors were monitored daily. On d 15, all piglets were euthanized and intestinal samples were collected for histology. Data were analyzed using PROC MIXED in SAS 9.4 and pig was the experimental unit. Throughout the 14-d dietary treatment phase, FI was greater overall (P < 0.01; 60.3%) in GLU compared to A and NA pigs and tended to be greater (P = 0.08; 37.7%) in A compared to NA pigs. BW was greater overall (P < 0.01; 8.7%) in GLU and A compared to NA pigs, but no differences were detected between A and GLU pigs. Lying behavior was greater (P = 0.05; 11.7%) in NA compared to A and GLU piglets in the first 2 d following simulated transport, indicating greater illness behavior in NA pigs. The villus height to crypt depth ratio was greater (P < 0.05) in the duodenum (12.1%) and jejunum (12.8%) for A and GLU compared to NA pigs and greater in the ileum (15.6%) for GLU compared to A and NA pigs. No temperature by diet treatment differences were observed with any comparison. In summary, withholding dietary antibiotics after weaning and transport can increase illness behaviors, reduce productivity, and negatively alter intestinal morphology compared to dietary antibiotic or L-glutamine provision.

Key Words: antibiotics, heat stress, transport