Reproductive Performance of Gilts Following Exposure to Heat Stress Prior to Breeding and in Early Gestation[1]

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Story in Brief

Two trials were conducted to study the influence of high ambient temperatures prior to breeding and in early pregnancy on the reproductive performance of gilts. Two environmental control chambers were used with one maintained at 74°F. continuously and the other elevated to 100°F. for 17 hours daily and lowered to 90°F. for the remaining 7 hours.

When gilts were exposed to high ambient temperatures the cycle before breeding, the onset of estrus was delayed by over 2 days, but no significant changes were noted in the number of gilts conceiving, the ovulation rates, or the number or size of embryos at 30 days postbreeding.

Heat stress applied 1-15 days postbreeding was more detrimental to productivity than heat stress 15-30 days postbreeding. Gilts maintained in the hot chamber the first 15 days after breeding had fewer viable embryos and lower survival rates than either those maintained in the cool chamber or in the outside pasture lots.

Based on these results, heat stress during estrus and in early gestation is more critical than heat stress prior to breeding. Gilts are more susceptible to high ambient temperatures the first few days after breeding than after implantation has occurred. Since August and September farrowed litters are smaller and pigs weigh less at weaning than those born in January and February, investigations to determine the influence of heat stress during mid and late pregnancy are presently being pursued.

Introduction

Multiple farrowing of swine has become increasingly popular in recent years. One disadvantage to this system of production is the lowered reproductive performance from sows and gilts during the hot summer

[1] Department of Animal Science in cooperation with USDA, ARS, AHRD, and Department of Agricultural Engineering.

months. Previous observations made at this station indicate that sows farrowing in August and September farrow and wean fewer pigs per litter, and the fall pigs are lighter at weaning. This is readily apparent when comparing the fall and spring litter production of control line (no selection line) gilts for the past four years at Ft. Reno (Table 1).

This study was undertaken to investigate the effect of high ambient temperatures prior to breeding and in early gestation on the estrual cycle, conception rate and subsequent embryo survival of crossbred gilts.

Materials and Methods

Two trials were conducted utilizing two environmental chambers in each trial. These chambers were constructed inside a closed building at the Ft. Reno Livestock Research Station. One chamber served as a control and was maintained at an ambient temperature of 74°F. continuously.

The temperature in the other chamber was elevated to 100°F. for 17 hours daily (4 p.m. to 9 a.m.) and lowered to 90°F. for the remaining 7 hours (9 a.m. to 4 p.m.). No atempt was made to regulate humidity, but it averaged approximately 35 percent in the heat chamber and 65 percent in the cool chamber. Each chamber was equipped with an artificial light source, but length of the photoperiod within the chambers was not strictly controlled. The dimensions and general layout of the chambers are presented in Figures 1 and 2.

Each gilt was fed 2½ pounds of feed morning and evening and water was supplied *ad libitum*. Yearling Hampshire boars were used to breed the gilts in both trials.

Table 1. Comparison of Fall and Spring Farrowed Litters Of Control Line Population Gilts at Fort Reno Station[1]

Year	Season	Number of Litters	Farrowing		42-Days	
			No. Pigs Per Liter	Avg. Pig Wt., lbs.	No. Pigs Per Litter	Avg. Pig Wt., lbs.
1964	Spring	10	11.0	2.7	8.0	49.3
	Fall	16	6.7	2.5	4.7	44.7
1965	Spring	14	10.5	2.6	7.5	43.1
	Fall	14	9.1	2.6	7.3	39.2
1966	Spring	21	11.8	2.6	8.8	37.5
	Fall	17	10.6	2.8	9.1	36.0
1967	Spring	20	10.6	2.8	9.3	43.5
	Fall	12	9.4	2.8	7.6	40.2
Overall	Spring	65	11.0	2.7	8.4	45.8
	Fall	59	9.0	2.7	7.2	40.0

[1] Spring refers to January and February farrowed litters and fall refers to August and September farrowed litters.

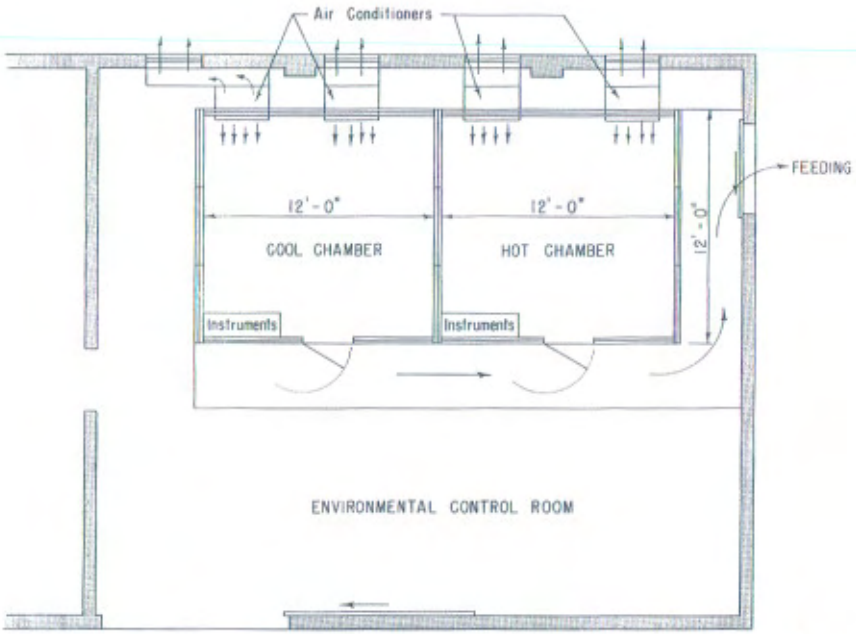

Figure 1. Environmental control room showing location of environmental control chambers, work area, and access walk for moving gilts in and out of the chamber.

Rectal temperatures were obtained twice daily from each gilt in each chamber. One reading was obtained at 4 p.m. before the heat was increased and the other at 11 p.m. These times were selected in an effort to obtain the maximum and minimum body temperatures. All gilts were slaughtered between the 30th and 35th day of gestation and intact reproductive tracts were recovered. The uterine horns were dissected and the embryos removed and examined. Crown-rump measurements were made with embryos still enclosed in the amnionic sac. Hemorrhagic and partially decomposed embryos were noted, but such embryos were not measured. Ovaries were removed and corpora lutea counted and verified by dissection.

Trial 1, conducted from February through April of 1967, was designed to study the influence of heat stress prior to breeding. Seventeen gilts were assigned to the cool chamber and 22 were assigned to the heat chamber for one estrous cycle prior to breeding. After breeding, the gilts were maintained in outside lots until time of slaughter.

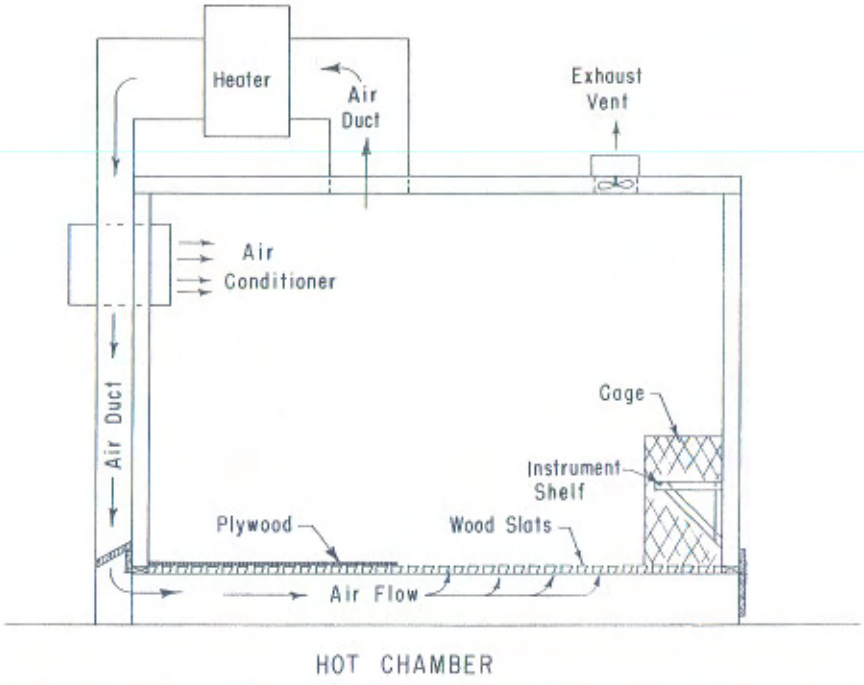

Figure 2. Cross section of high temperature environment control chamber, showing location of air conditioners, heating facilities, instrument cage and exhaust fan.

Trial 2 consisted of two replications. One was conducted during March and April and the other during November and December of 1967. Sixty crossbred gilts were randomly assigned to four treatments at time of breeding on first day of estrus. In treatment 1 the gilts were maintained in the hot chamber for the first 15 days after breeding and then were maintained in the regular Ft. Reno sow facilities until slaughter at about 30 days postbreeding.

In treatment 2, gilts were kept in the regular outside sow facilities for the first 15 days after breeding and then placed in the hot room from 15-30 days postbreeding. Treatment 3 gilts were confined to the control chamber from breeding until slaughter at about 30 days postbreeding. Treatment 4 gilts were maintained in the outside lots from breeding until slaughter.

Results and Discussion

Trial 1:

Average rectal temperatures for the gilts in trial 1 are presented graphically in Figure 3. The gilts showed definite response to the high temperatures for the first 6-8 days of exposure and then apparently became somewhat adjusted to the stress conditions. However, rectal temperatures for the gilts exposed to the heat chamber remained well above what is considered normal (102.5°F.) for the entire time of exposure. In contrast, rectal temperatures for gilts maintained in the cool chamber were slightly below normal.

Five gilts exposed to the heat chamber in trial 1 died during the heat stress period and one failed to conceive. The reproductive performance of the remaining 33 gilts is summarized in Table 2. Among gilts alloted to the control chamber, no significant differences were found between the estrous cycle lengths during confinement and the average of the two cycles prior to confinement. However, the cycle lengths were increased ($P<.05$) during confinement for the gilts alloted to the heat chamber. Other differences observed in reproductive performance were not significant. The gilts exposed to the heat stress suffered a severe loss of appetite and, as a result, lost significantly more weight during confinement than those confined to the cool chamber.

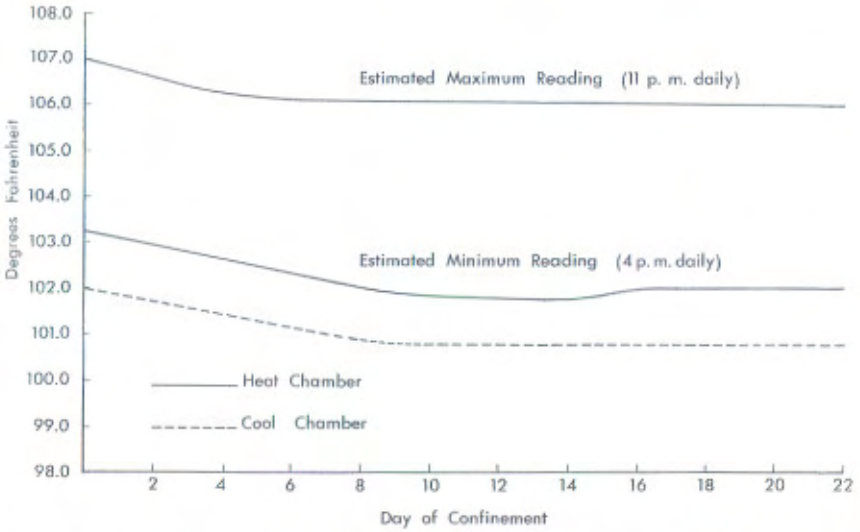

Figure 3. Average rectal temperatures for cool chamber and heat chamber gilts during chamber confinement.

Table 2. Influence of High Ambient Temperatures On Estrous Cycle Prior to Breeding

Item	Treatment Cycle Before Breeding	
	Hot Room	Cool Room
No. gilts allotted	17	17
No. pregnant at 30 days	16	17
Length of estrous cycle, days:		
Prior to confinement	20.0[1]	21.4
During confinement	22.4[2]	21.5
No. corpora lutea per gilt	15.5	15.9
No. viable embryos per gilt	11.5	12.4
Percent viable of ovulated	74.2	78.0
Adjusted embryo length, mm.	28.3	29.0

[1,2] Values with different superscripts significantly different ($P < .05$).

Trial 2:

Rectal temperatures of heat stressed gilts in trial 2 followed the same pattern as those in trial 1. Readings obtained from animals in the heat chamber were significantly higher than those in the cool chamber.

Of the 15 gilts assigned to treatment 1, four failed to conceive and one died during the stress period. Two gilts in treatment 2 and one from treatment 4 also failed to conceive. The reproductive performance of the remaining 52 gilts is summarized in Table 3. Conception rates were lowest among the gilts exposed to heat stress 1-15 days post-breeding. No significant differences were found in number of corpora lutea among the four treatments. However, gilts stressed 1-15 days post-breeding had significantly ($P < .01$) fewer viable embryos and significant-

Table 3. Influence of High Ambient Temperatures During Early Pregnancy

Item	Postbreeding Treatment[1]			
	Hot Room (1-15)	Hot Room (15-30)	Cool Room (1-30)	Pasture (1-30)
No. gilts allotted	15[2]	15	15	15
No. pregnant at 30 days	10	13	15	14
No. corpora lutea/gilt	14.6	15.4	15.2	13.8
Viable embryos/gilt	9.4[3]	12.8[4]	12.6[4]	11.5[4]
Percent viable of ovulated	64.2[3]	83.4[4]	82.8[4]	83.4[4]
Adjusted embryo length, mm.	30.09	31.08	31.38	31.76

[1] Figures in parenthesis refer to the days of postbreeding phase that gilts exposed to treatment.
[2] Includes one gilt that died during stress period.
[3,4] Values with different superscripts significantly different ($P < .01$).

ly ($P<.01$) lower survival rates. Embryos at 30 days postbreeding tended to be smaller but these differences were not significant.

The results of this study indicate that heat stress during early gestation is more of a factor in embryonic mortality than heat stress prior to breeding. It also appears that the embryo is more susceptible to heat stress during the first 15 days postbreeding than in the period 15-30 days postbreeding.

Summary Reports on Other Projects

Mineral Interrelationship Studies With Ruminants

Allen D. Tillman, T. E. Nelson and L. J. Bush

Procedures and Results

In work done on this project during the past year, it was found that both adult sheep and laboratory rats responded to a calcium-free diet in a similar manner: There was a linear decrease in blood plasma calcium level for three weeks, but by the end of the fourth week the levels had returned to a normal level and remained in the normal range for the five-week period the rats were on test and for 25 weeks in the case of sheep. Plasma phosphorus levels rose at the time the calcium levels returned to normal, thus the calcium x phosphorus product in blood plasma rose to high level. The data show that a calcium x phosphorus product of 70 or above indicates that the animal is receiving an insufficient amount of dietary calcium thus is drawing this element from the bones.

Sheep, which had been on the calcium-free diet for six weeks or more excreted injected phosphorus more rapidly than those maintained on an adequate dietary level of calcium. These results indicate that the parathyroid hormone activity was higher in calcium-deficient sheep. As the kidney arterial-venous blood differences were greater in calcium-deficient sheep than the controls, these results lend further support to