Reproductive Performance of Boars After Exposure to Elevated Ambient Temperature

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Story in Brief

When six Yorkshire boars were subjected to 94°F ambient temperature they had higher rectal temperatures and respiration rates than six control boars at 74°F. Semen volume and gel weight per ejaculum were not altered during elevated ambient temperature but sperm motility was decreased and the number of aged acrosomes increased by the second week of treatment. This reduction in semen quality was associated with a reduction in fertility.

When gilts were inseminated with semen from hot boars, conception rate was decreased from 42 percent to 28 percent. Gilts bred to hot boars had 6.1±.6 embryos at day 30 of pregnancy whereas gilts bred to control boars had 8.6±.7 embryos. After 90 days of heat treatment the boars were castrated and sperm numbers were determined in the testes and epididymides. Hot boars had about half as many testicular and epididymidal sperm as control boars. Although exposure of boars to elevated ambient temperature can cause a reduction in semen quality and fertility, the volume of semen produced and the libido of the boars may not be affected. Therefore, careful management of the temperature of boars during hot periods can greatly influence the number of females settled and the litter size during the next breeding season.

Introduction

A costly reduction in reproductive efficiency in swine is commonly observed during the summer months. Previous research has demonstrated that exposure of gilts to high ambient temperature during early pregnancy causes a marked reduction in embryo survival, but it appears that problems during the summer months may be due to heat stress on the boar as well as on the gilt.

Local heating of the scrotum of boars for three hours causes a reduction in the number of live sperm cells that are ejaculated two weeks later. When boars were exposed to elvated ambient temperature for three days, Wisconsin workers found a decrease in sperm concentration

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and increased abnormal sperm in semen collected after treatment. The purposes of this experiment were to determine semen quality, fertility and sperm reserves after exposure of boars to elevated ambient temperature for six weeks.

Experimental Design

In each of two replicates, three Yorkshire boars of proven fertility were allotted to each of two temperature controlled chambers. After a two-week adjustment period at 74°F, control boars were maintained at 74°F and treated boars were exposed to 88°F from 5 p.m. to 9 a.m. and 94°F from 9 a.m. to 5 p.m. Feed intake was controlled and boars gained about 0.5 lbs. per day. Rectal temperatures and respiration rates were recorded twice daily at 9 a.m. and 1 p.m. Boars were ejaculated twice weekly by the gloved hand technique and semen volume, gel weight, sperm concentration, motility and aged acrosomes were determined. During days 45 to 80 of treatment, semen was collected from both control and hot boars and tested for fertility. Gilts were inseminated twice, at 24-hour intervals, with about 6 billion sperm. Each boar was mated to approximately 12 gilts. After 90 days of treatment, boars were castrated and gonadal and epididymidal sperm numbers were determined.

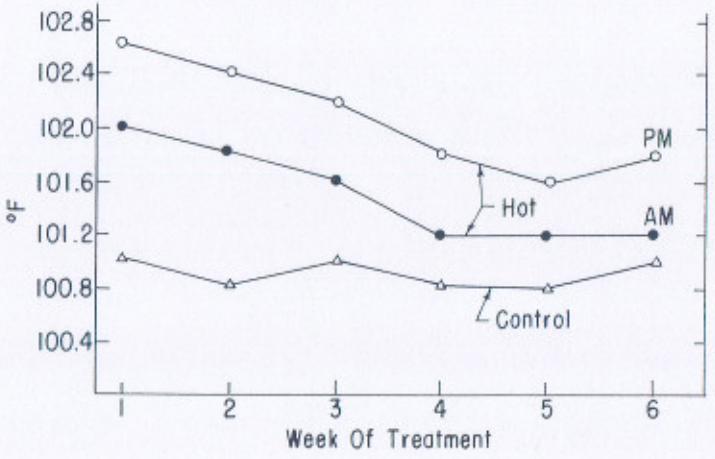

Figure 1. Rectal Temperature of Boars During Elevated Ambient Temperature

Results

Rectal temperatures (Figure 1) were highest in hot boars in the a.m. after exposure to 94°. Maximal temperature in the hot boars was 102.6°F, occurring during the first week of treatment. Rectal temperature of hot boars decreased to 101.7° after five weeks, suggesting a partial adjustment to the heat. On Figure 2, respiration rates for the boars are plotted. Control boars averaged 24 respirations per minute and the maximum rate in hot boars was almost fivefold greater. Respiration rates of hot boars were greatest in the p.m. after exposure to 94° for 4 hours. The elevations in respiration and temperature are indicators that the boars were stressed by ambient temperatures of 88° and 94°F.

Control and hot boars produced similar numbers of sperm before and during the first several weeks of treatment (Table 1). Sperm numbers ejaculated by hot boars were reduced on the third and sixth weeks of treatment. A reduction in the number of sperm ejaculated may not be seen until after about six weeks of heat treatment because this is the approximate length of time required for the production and maturation of sperm in the testes and epididymides.

The sperm reserves of the testes and epididymides after 90 days of heat treatment are compared with control boars in Table 2. The weights of the testes and epididymides were similar for control and treated boars. But total testicular sperm was reduced by elevated temperature. Testes from control boars contained 104 billion sperm and treated boars only had 52 billion sperm. Similarly, the numbers of sperm in the caput-

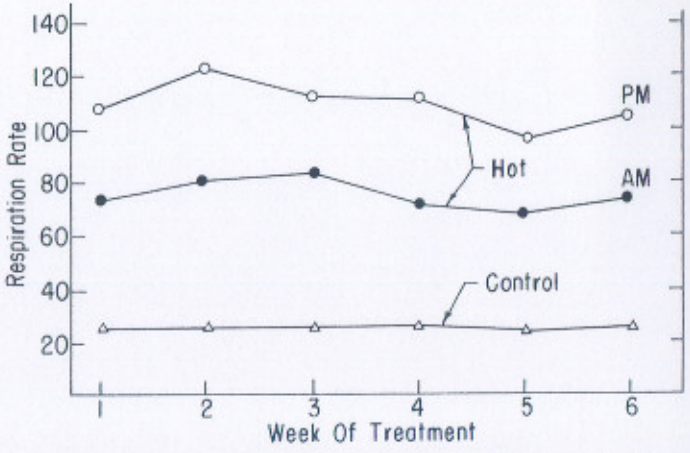

Figure 2. Respiration Rate of Boars During Elevated Ambient Temperature

Table 1. Total Sperm Per Ejaculate ($x10^9$) from Boars During Elevated Ambient Temperature

Treatment	Weeks before or during heat stress							
	−2	−1	1	2	3	4	5	6
Control	30	48	43	45	60	54	49	65
Hot	33	48	48	35	30	50	44	36

Table 2. Gonadal and Epididymidal Weight and Sperm Content of Yorkshire Boars After 90 Days of Heat Treatment

Criteria	Treatment	
	Control	Heat
Testes weight (gm)	939±39[1]	901±259
Total testes sperm ($X10^9$)	104±18	52±19
Caput-corpus weight (gm)	98±11	85±7
Caput-corpus sperm content ($X10^9$)	127±7	66±21
Cauda weight (gm)	98±7	83±7
Cauda sperm content ($X10^9$)	234±23	95±30

[1] Means ± standard errors for six boars.

corpus and cauda epididymides were reduced in heat treated boars to about half of the number in control boars. Thus, it appears that elevated ambient temperature altered the rate of spermatogenesis.

The volume of semen per ejaculum and weight of gel was not influenced by heat treatment. These values for hot boars are expressed as percentage change from control boars in Figure 3. Therefore, accessory gland function is probably not altered by elvated ambient temperature.

The quality of the sperm cells was altered by heat treatment. In figure 4 the percentage change in sperm motility and aged acrosomes for hot boars is compared to control boars. Sperm from hot boars were 20 percent less motile at two weeks after treatment and decreased to about 50 percent of the motility of sperm from control boars during three to five weeks of heat treatment. The percentage sperm cells from hot boars with aged acrosomes was increased. By two weeks of treatment, about 45 percent of the sperm from hot boars had aged acrosomes. During three to five weeks of treatment, sperm from hot boars had almost twice as many aged acrosomes as control boars. This decrease in motility and increase in aged acrosomes indicates that semen from hot boars may be less fertile.

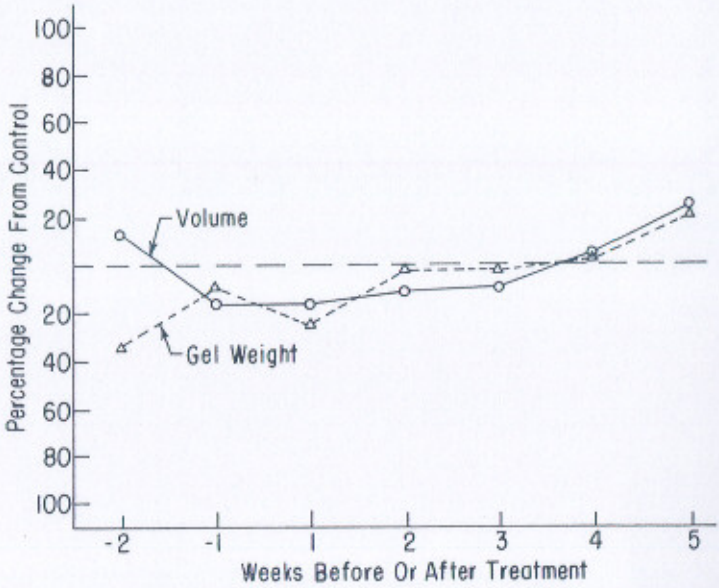

Figure 3. Semen Volume and Gel Weight During Elevated Ambient Temperature of Boars

The results of the fertility trial using artificial insemination are in Table 3. The number of gilts that became pregnant when bred with semen from control boars was low (42 percent), but only 28 percent of 77 gilts bred with semen from hot boars conceived. There was also a treatment effect on the number of embryos the gilts had when slaughtered at 30 days of pregnancy. Gilts that were bred with semen from control boars had an average of 8.6 embryos but gilts bred to hot boars had only 6.1 embryos. Thus, boars subjected to heat stress settled less gilts and there was a reduction in the litter size of those gilts that did become pregnant.

The formation of sperm is a continual process requiring about 40 days in most animals. If sperm are affected in the formation stages by increased body temperature due to either heat stress or a health problem that causes a fever, the influence may be apparent much later. Presently, we are conducting trials to determine how long the detrimental effect of elevated body temperature on semen quality exists after boars are returned to a cooler ambient temperature.

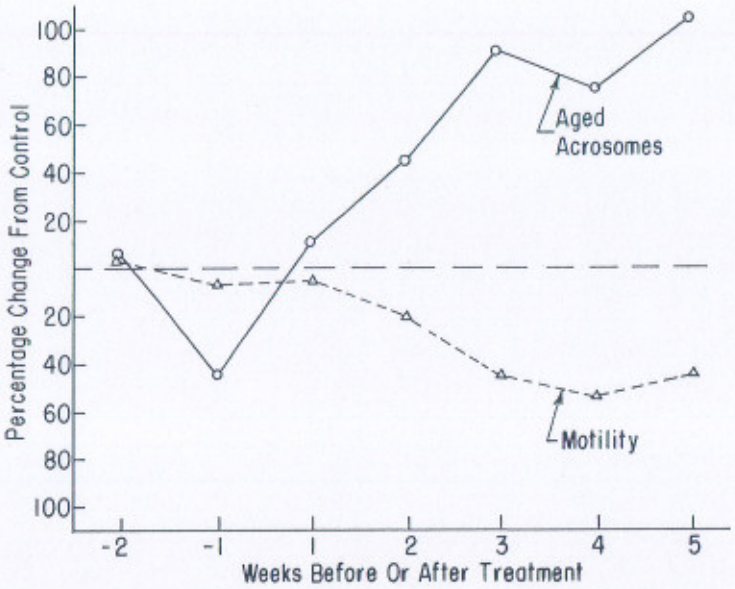

Figure 4. Sperm Motility and Percentage Aged Acrosomes During Elevated Ambient Temperature of Boars

Table 3. Influence of Heat Stress on Fertility of Boars

Treatment	No. boars	No. gilts bred	Gilts pregnant No.	Gilts pregnant %	No. embryos
Control	6	80	34	42	8.6±7
Hot	6	77	22	28	6.1±6