DISRUPTION OF THE OESTROUS CYCLE IN GILTS BY HEAT STRESS PRIOR TO OESTRUS

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SUMMARY

A total of 40 gilts was used to study the effects of heat stress (applied for 5 days) beginning either 6 days or 3 days before the expected date of oestrus on reproductive performance. In both experiments heating gilts reduced their feed intake from 2.0 to 1.5 kg per day and increased their rectal temperature by 1.8°C ($P \leq 0.001$). Gilts exposed to heat stress 6 days before oestrus had longer oestrous cycles ($P \leq 0.10$) by an average of 1.4 days. There was a negative correlation ($r = -0.52$, $p < 0.05$) between feed intake and length of the oestrous cycle. For gilts subjected to high temperatures 3 days before oestrus there was a negative correlation ($r = 0.60$, $P \leq 0.05$) between rectal temperature and the duration of oestrus, suggesting heat stress shortens oestrus. These results suggest there may be a critical period towards the end of the oestrous cycle in gilts where high temperatures may exert an effect on both the duration of oestrus and length of the oestrous cycle. However, a study of the endocrinology of the system is required to elucidate the possible mechanisms.

INTRODUCTION

Fertility of sows and gilts is often depressed when animals are mated during the summer months (Corteel *et al.* 1964; Steinbach 1972; Stone 1977; Wrathall 1977;. Love 1978; Paterson, Barker and Lindsay 1978; Hurtgen et *al.* 1980). Heat stress around the time of mating may affect ovarian function, resulting in temporary infertility and an endocrine imbalance which could lead to delayed, irregular returns to oestrus (Paterson et *al.* 1978).

Sawyer (1977) investigated the effects of high temperatures at the time of mating on Merino ewes and showed that the normal cyclical activity at oestrus was disrupted. In heated ewes where oestrus was delayed progesterone did not decline but remained high then delayed the pre-ovulatory surge in luteinisirig hormone (LH) and subsequent oestrus.

Similarly, Stott and Robinson (1970) observed higher progesterone levels in heat-stressed heifers which showed extended, irregular oestrous cycles.

It is hypothesised that heat stress in the pig is similar to that in sheep and cattle. The notion is that high ambient temperatures or stress conditions preceding oestrus alter the normal decline of progesterone which occurs at luteolysis and thereby prevent the normal progression of events in the oestrous cycle.

Reviewing the literature on heat stress suggests not only the duration

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of heat treatment but its timing in relation to the oestrous cycle may be important in determining the degree of effect on cyclical oestrous activity. Two experiments were conducted to determine, firstly, the effect of heat stress on gilts six days before the expected commencement of oestrus, encompassing luteal regression and the follicular phase, and secondly, to determine the effect of heat stress three days before the expected date of oestrus, encompassing the immediate phase prior to behavioural oestrus.

MATERIALS AND METHODS

In the first experiment 15 large white landrace cross gilts were introduced to a hot room (32°C for 7 h and 38°C for 17 h) six days before their expected dates of oestrus. After remaining in the hot room for five days they were moved to a control room maintained at approximately 20°C. Five gilts were maintained in the control room throughout the experiment. The second experiment was identical to the first except that the heat treatment commenced three days before the expected date for commencement of oestrus. All animals were offered 2.0 kg of dry sow ration daily.

Feed intake (residues) and rectal temperature were monitored daily in the hot chamber. Detection of oestrus and duration were checked daily, commencing two days before the expected oestrus with a vasectomised boar. A gilt was judged to display oestrus when she allowed the boar to mount. Ovarian activity and ovulation rate were determined by laparoscopy.

Oestrous behaviour, ovarian activity and ovulation rate were monitored through to the subsequent oestrus (post-heated oestrus) to determine any residual effect of heat treatment in the next cycle.

Data for rectal temperature and feed intake were analysed by student's t-test. Linear regression and correlation analyses were used to test for any association between two discrete variables. The reproductive performance data were analysed by an analysis of variance for a 2 x 2 factorial experiment with unequal replication.

RESULTS

A. Response of animals to heating:

In both experiments, heating of gilts reduced their feed intake from 2.0 to 1.5 kg per day ($P \leq 0.05$), feed residues ranged from none to 1.9 kg per day, In the second experiment, depressed feed intake resulted in an average body weight loss of 3 kg (range 1 to 10 kg) during the five-day heat treatment. Rectal temperature was increased by 1.8°C ($P \leq 0.001$) in the heated gilts in experiments 1 and 2.

B. Reproductive performance:

Gilts exposed to heat stress six days before the expected date of oestrus had longer oestrous cycles ($P \leq 0.10$) by an average of 1.4 days (Table 1). There was a negative correlation ($r = 0.52$, $P \leq 0.05$) between feed intake and length of the oestrous cycle during which treatment was imposed in the heated gilts. The duration of oestrus and ovulation rate were not affected by the heat stress applied six days before oestrus.

TABLE 1.

Effect of heat stress applied 6 days prior to the expected oestrus on reproductive performance of gilts (mean and standard error)

	Heated	Control
Number of gilts allocated	15	5
Duration of oestrus (days)	2.4 ± 0.1	2.8 ± 0.2
Ovulation rate	11.1 ± 0.5	11.6 ± 0.3
Length of oestrous cycle (days)	20.2 ± 0.4	18.8 ± 0.7 ($P \leq 0.10$)

Gilts subjected to high ambient temperatures three days before oestrus had normal oestrous'cycle length (Table 2). There was no difference in the mean duration of oestrus between the heated and control gilts. However, there was a negative correlation ($r = -0.60$, $P \leq 0.05$) between rectal temperature and the duration of oestrus for the heated group. Half of the gilts heated three days prior to oestrus displayed oestrus for only one day. In the post-heated cycle the number of heated animals receptive to the boar for only one day was decreased by 30 percent, or conversely, there was a 30 percent increase in animals standing for three days.

TABLE 2.

Effect of heat stress applied 3 days prior to the expected oestrus on reproductive performance of gilts (mean and standard error)

	Heated	Control
Number of gilts allocated	15	5
Duration of oestrus (days)	1.7 ± 0.2	1.8 ± 0.3
Ovulation rate	10.9 ± 0.5	10.8 ± 1.5 12.0 ± 1.2†
Length of oestrous cycle (days)	19.9 ± 0.3	19.5 ± 0.6

† One animal was removed from analysis with abnormally low ovulation rate.

There was no direct effect of heat stress on ovulation rate in the first experiment. Depressed feed intake, resulting in substantial bodyweight losses during the heat treatment in the second experiment, may have been responsible for differences measured (Table 2).

The effects of heat stress observed in experiments 1 and 2 are confined to the oestrous cycle during which treatment was imposed. Where cyclic activity was disturbed, normal function was resumed in the next oestrous cycle.

DISCUSSION

These results suggest high ambient temperatures before oestrus can extend the length of the oestrous cycle and reduce the length of time the gilt is receptive to the boar. It is not known whether these two responses are different expressions of the same disruption and reflect different degrees of reaction to stress or whether the effects are caused by two distinct mechanisms.

The main effects of exposure to heat stress before mating are confined to interference with cyclical activity, although without mating the animals their subsequent reproductive performance is not known. Sawyer (1977) found no difference in reproductive performances of ewes inseminated from both control and heat treatment groups.

Both physiological responses of depressed feed intake and elevated body temperature were prominent during the first three days of heat treatment. After this point several animals displayed the capacity to acclimatise to the extreme environmental regime. Reid and Mills (1962) reported that measured effects of environmental stress are likely to be extremely variable, but the degree of response declines as the animal becomes acclimatised to the experimental conditions. Interference with cyclical oestrous activity may well be a graduated effect, and this could well be illustrated by the length of time a gilt remained receptive to the boar.

Ovulation rate was not directly affected by high temperatures before mating. The differences observed were reflecting a nutritional effect rather than a direct effect of heat. In the second experiment, where the greatest effect was measured, all the heat-treated animals averaged a 3 kg loss in body weight during the stress treatment. This effect may be exaggerated where body reserves are limiting.

This study suggests there is a critical period towards the end of the oestrous cycle in gilts where high temperatures may exert an effect. This period includes corpus luteum regression, maturation of follicles and release of gonadotrophins and ovarian hormones responsible for oestrus and ovulation, and initiation of another oestrous cycle. There may be several degrees of disruption to normal cyclical oestrous activity which seem to be a function of the timing of heat stress in relation to the stage of the oestrous cycle, its severity and, possibly, state of nutrition of the animals.

A study of the endocrinology of the system is required to elucidate the possible mechanisms.

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