



# Fertility of Sows Injected with Exogenous Estradiol and/or Gonadotropins to Control Post-Weaning Estrus

## Technical Report No. 8

### Abstract

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In the first of two experiments 28 multiparous sows were allocated to one of the following treatments two days after weaning at approximately 35 days postpartum: (1) untreated; (2) i.m. injection 10 µg estradiol benzoate (OB)/kg body weight (b. wt.); and (3) i.m. injection 20 µg OB/kg b. wt. Sows were bred at first post-weaning estrus and ovulation rate assessed at slaughter. The mean interval from weaning to estrus in each group was: (1) 5.6 ± 0.2; (2) 4.7 ± 0.2; and (3) 4.7 ± 0.2 days; the mean ovulation rates in groups 1 and 2 (18.7 ± 0.6 and 17.4 ± 1.8, respectively) were significantly higher ( $P < 0.01$ ) than that of 12.0 ± 1.7 for treatment 3 sows. Two untreated and one each of the treated sows were not cycling at slaughter.

In the second experiment 75 multiparous sows weaned at 28 ± 3 days postpartum (day 0) were evenly allocated with respect to parity to one

of four treatment groups: (1) untreated; (2) i.m. injection 10 µg OB/kg b. wt. on day 2; (3) P.G. 600<sup>®</sup> (400 I.U. PMSG + 200 I.U. HCG) injection subcutaneous day 0; and (4) combined P.G. 600/OB treatment as in (2) and (3) above. Sows were bred naturally at the first post-weaning estrus and fertility assessed at farrowing. Control animals had a significantly longer ( $P < 0.05$ ) weaning to estrus interval (4.53 ± 0.25 days) compared to treatment 2 (4.03 ± 0.13), treatment 3 (3.97 ± 0.12) and treatment 4 (3.81 ± 0.07) sows. Sows treated with P.G. 600<sup>®</sup> alone showed a significant increase ( $P < 0.05$ ) in numbers born live compared to pre-treatment values. A smaller and nonsignificant increase in numbers born live in control sows (probably related to increasing parity) was not observed in either OB or P.G. 600/OB-treated animals.

These results suggest that with further modification of the treatments, a system may be developed for introducing fixed-time artificial insemination (AI) or mating as a means of controlling the reproductive performance of the weaned sow.

### Introduction

Lactation in the pig is usually accompanied by a period of anestrus and anovulation. A proportion of females, and in particular primiparous gilts, can also have extended intervals from weaning to subsequent estrus (Brooks and Cole, 1972; Fahmy et al., 1979) which results in reduced production efficiency of the herd. Exogenous hormone therapy has had limited success as a means of inducing estrus and ovulation during lactation (Cole and Hughes, 1946; Heitman and Cole, 1956; Crighton, 1970; Guthrie et al., 1978), whereas treatment at about the time of weaning has been more successful. Data from Edwards and Foxcroft (1983) indicate that estrogen treatment induces a highly synchronous return to estrus and ovulation in the weaned sow when given on the second day after weaning; however, ovulation rates tended to be reduced at the dose level of 30 µg/kg body weight (b. wt.) employed. The use of diethylstilbestrol or a combination of steroids has also been associated with reduced conception rates and litter sizes at term (Rasbech, 1953; De la Cerna, 1956; Rigor et al., 1968; Smidt et al., 1968; Dyck et al., 1979). PMSG and HCG have been used alone or in combination, but variations in the treatment regimes and dosages employed make a comparison of the results difficult. The use of HCG alone leads to reduced conception

rates (Rasbech, 1953; Radford, 1965), whereas treatment with PMSG at the time of weaning generally results in an increase in litter size and a reduction in the weaning to estrus interval (Longenecker and Day, 1968; Tomes, 1978). Combinations of PMSG or FSH and HCG have also been used with success to synchronize estrus and increase ovulation rate (Christenson and Teague, 1975; Fisher et al., 1976; Whyte, 1977; Webster, 1978). Whereas exogenous gonadotropin treatment therefore appears to be of use in increasing overall fertility in the weaned sow, treatment with exogenous estrogens potentially offers the additional advantage of strictly synchronizing the time of ovulation in groups of weaned animals. This would be an advantage in controlled breeding programs and in promoting fixed-time AI as a routine procedure.

The present collaborative experiments were therefore undertaken to compare firstly the fertility of weaned sows receiving varying doses of exogenous estrogen and slaughtered in early pregnancy and secondly, the use of PMSG/HCG (P.G. 600<sup>®</sup>) alone and in combination with estrogen treatment to control reproductive performance in sows in which fertility was assessed at farrowing.

## Materials and Methods

### Experiment 1:

Twenty-eight multiparous sows (Large White or Large White X Landrace from the University College Dublin herd) were weaned at approximately 35 days postpartum and randomly assigned to one of three treatments: (1) untreated controls; (2) 10 µg estradiol benzoate (OB) per kg body weight (b. wt.) (OB in ethyl oleate, 5 mg/ml; Intervet Laboratories Ltd., Cambridge); and (3) 20 µg OB/kg b. wt. OB was administered by intramuscular (i.m.) injection at 09:30 to 10:00 hours on day 2 post-weaning (weaning - day 0). Sows were checked for estrus twice daily using a vasectomized boar, were classified as being in estrus when they stood for mating and the weaning to estrus interval was recorded. Sows in estrus were bred twice either naturally or using artificial insemination at 16 to 24 hour intervals and all sows were slaughtered between days 3 to 7 and 25 to 35 postcoitum. The ovaries were examined macroscopically and the number of corpora lutea recorded. Acute blood samples were obtained from the ear vein at 8, 24, 48, 96 and 144 hours following OB injection from 4, 5 and 6 sows representing treatment groups 1 to 3 respectively and plasma estradiol—17β concentrations determined by the method of Foxcroft et al. (1984). All samples were

run in a single assay in duplicate; the sensitivity of the assay was 7.0 pg/ml and the intra-assay coefficient of variance was 8%.

### Experiment 2:

Based on the preliminary results of Experiment 1, 75 multiparous sows (Large White or Landrace X (Landrace X Large White) from the University of Nottingham herd) were weaned at 28 ± 3 days post-partum and were evenly allocated, with respect to parity, to one of four treatment groups: (1) untreated controls; (2) i.m. injection of OB (10 µg/kg b. wt.) in ethyl oleate at 09:00 to 10:00 hours day 2 after weaning (day 2); (3) subcutaneous (s.c.) injection of P.G. 600<sup>®</sup> (400 in PMSG and 200 in HCG dissolved in 5 ml of sterile saline; Intervet Laboratories Ltd., Cambridge) immediately after weaning at 09:00 to 10:00 hours day 0; (4) s.c. injection of P.G. 600<sup>®</sup> immediately after weaning at 09:00 to 10:00 hours day 0 followed by i.m. injection of OB (10 µg/kg b. wt.) at 09:00 to 10:00 hours day 2. All sows had at least six piglets at weaning. Testing for estrus was performed twice daily commencing on day 3. At the first testing period a mature boar was brought to the group of weaned animals and the behavioral responses of the sows noted; any animal found

to be in heat was served. Subsequent testing involved taking individual sows to a boar pen. Sows were served at the first standing estrus and at the next two testing periods by the same boar. Services by individual boars were evenly distributed between treatment groups. Data were collected from the previous farrowing performance of individual sows prior to inclusion in the trial and also from the subsequent post-treatment farrowing. The parameters recorded were: postpartum weight, total number born (alive and dead), total litter weight on day 1, number weaned, total litter weight at weaning, sow weight at weaning, sow weight at service and weaning to estrus interval.

The data from both experiments were subjected to analysis of variance and where significant treatment effects were established, differences between group means were analyzed by Student's t-test. For Experiment 2, sows which were classified as anestrus by the criteria of Meredith (1979) (weaning at least 10 days without displaying estrus) were omitted from the statistical analysis.

## RESULTS

### Experiment 1:

A summary of the data related to estrus and ovulation is contained in Table 1. Despite an earlier mean time to estrus in both OB-treated groups, there was no significant difference in the interval from weaning to estrus between treatments. Although the dose of 20 µg/kg b. wt. significantly lowered ( $P < 0.01$ ) ovulation rates, there was no significant difference in the ovulation rate between control sows and those treated with 10 µg/kg b. wt.

The maximum plasma estradiol concentrations of the four control animals studied were 16.8, 17.2, 44.0 and 51.6 pg/ml and occurred in samples drawn at 48, 8, 144 and 8 hour post-treatment respectively. The mean ( $\pm$  SEM) plasma estradiol concentrations 8, 24, 48, 96 and 144 hours post-injection in animals treated with 10 µg OB/kg b. wt. were  $85 \pm 13$ ,  $66 \pm 7.39 \pm 10$ ,  $17 \pm 4$  and  $10 \pm 3$  pg/ml respectively and were lower but not significantly different to the levels in animals treated with 20 µg OB/kg b. wt. of  $112 \pm 24$ ,  $91 \pm 21$ ,  $72 \pm 26$ ,  $28 \pm 10$  and  $29 \pm 21$  pg/ml respectively.

### Experiment 2:

All but seven of the sows exhibited estrus 3 to 10 days after weaning. Fertility data for these animals are summarized in Table 2. The omitted animals had weaning to estrus intervals of 13 (control group), 16 and 47 (OB group) and 11, 12, 22 and 28 days (P.G. 600® group). Pre-treatment means of each parameter did not differ significantly between groups, although numbers of piglets born alive (NBL) was marginally higher in the control group.

The weaning to estrus interval immediately post-treatment was significantly lower ( $P < 0.05$ ) in all treatment groups compared to controls. Comparing post-treatment responses between groups, NBL were significantly lower in the OB and P.G. 600®/OB-treated animals compared to controls ( $P < 0.05$ ) and to treatment with P.G. 600® alone ( $P < 0.01$ ). Again, with respect to NBL, the only significant difference between pre- and post-treatment values within each group was the increase ( $P < 0.05$ ) observed in response to administration of P.G. 600® alone. Treated animals did not significantly differ from controls in conception rates or numbers of piglets born dead.

## DISCUSSION

The experimental protocols used in these trials were designed to allow a comparison of the relative fertility of weaned sows in which a synchronized and early return to estrus (and ovulation) was induced with estradiol and/or gonadotropin therapy.

In the first experiment the synchronisation of estrus in OB-treated animals was accompanied by a nonsignificant reduction in the weaning to estrus interval of approximately 1 day and these data are consistent with the results of previous authors (Rigor et al., 1968; Smidt et al., 1968; Edwards and Foxcroft, 1983).

Reducing the dose of estrogen from 30 µg/kg b. wt., used previously by Edwards and Foxcroft (1983), to 20 µg/kg b. wt. failed to overcome the problem of a reduced ovulation rate, whereas a further reduction to 10 µg/kg b. wt. resulted in mean ovulation rates which were not significantly different to controls. The effect of OB treatment on ovulation rate may, therefore, be dose-dependent.

**Table 1.**

**Summary of Estrus and Ovulation Data Following Estradiol Benzoate Treatment in Sows 2 Days after Weaning**

	Dose estradiol benzoate used		
	0	10 µ/kg	20 µ/kg
Number of sows treated	9	9	10
Mean ( $\pm$ SEM) body weight (kg)	183.5 $\pm$ 11.3	191.1 $\pm$ 6.2	181.2 $\pm$ 5.7
Number of sows acyclic at slaughter	2	1	1
Mean ( $\pm$ SEM) weaning to estrus interval (days) in sows returning to estrus	5.6 $\pm$ 0.2	4.7 $\pm$ 0.2	4.7 $\pm$ 0.2
Mean ( $\pm$ SEM) number of ovulations	18.7 $\pm$ 0.6 <sup>a</sup>	17.4 $\pm$ 1.8 <sup>a</sup>	12.0 $\pm$ 1.7 <sup>b</sup>

<sup>ab</sup> numbers in rows with superscripts are significantly different ( $P < 0.01$ ).

**Table 2.**

**Summary of Fertility Data following Exogenous Gonadotropin (400 IU PMSG + 200 IU HCG: P.G. 600®) and/or Estradiol Benzoate Treatment Post-weaning in Sows with a Weaning to Estrus Interval < 10 Days**

	Controls	Estradiol benzoate	P.G. 600®	P.G. 600®+ Estradiol benzoate
No. sows treated	18	16	16	18
Average parity (mean $\pm$ SEM)	4.0 $\pm$ 0.6	4.5 $\pm$ 0.7	3.9 $\pm$ 0.7	4.1 $\pm$ 0.7
No. piglets born alive, pre-treatment	11.0 $\pm$ 0.68	9.81 $\pm$ 0.45	9.88 $\pm$ 0.681	9.78 $\pm$ 0.58
No. piglets born dead, pre-treatment	0.39 $\pm$ 0.24	0.69 $\pm$ 0.40	0.44 $\pm$ 0.22	1.06 $\pm$ 0.47
Sow weight at weaning (kg)	170.8 $\pm$ 5.5	168.4 $\pm$ 5.1	165.9 $\pm$ 5.9	174.8 $\pm$ 5.3
Weaning-to-estrus interval (days), post-treatment	4.53 $\pm$ 0.25 <sup>a</sup>	4.03 $\pm$ 0.13 <sup>b</sup>	3.97 $\pm$ 0.12 <sup>b</sup>	3.81 $\pm$ 0.07 <sup>b</sup>
Conception rate	17/18 94.4%	15/16 93.8%	15/16 93.8%	15/18 83.3%
No. piglets born alive, post-treatment	11.65 $\pm$ 0.53 <sup>a</sup> n = 17	9.60 $\pm$ 0.67 <sup>bc</sup> n = 15	12.15 $\pm$ 0.46 <sup>de</sup> *n = 13	9.67 $\pm$ 0.49 <sup>bc</sup> n = 15
No. piglets born dead, post-treatment	0.88 $\pm$ 0.34	0.60 $\pm$ 0.35	0.77 $\pm$ 0.31	1.40 $\pm$ 0.25
Subsequent weaning to estrus interval (days)	4.12 $\pm$ 0.11 n = 13	4.25 $\pm$ 0.17 n = 12	4.5 $\pm$ 0.43 n = 12	5.00 $\pm$ 0.37 n = 13

<sup>b</sup>numbers in same row with different superscripts are significantly different ( $P < 0.05$ ).

<sup>a</sup>numbers in same row with different superscripts are significantly different ( $P < 0.01$ ).

<sup>c</sup>numbers in same column with different superscripts are significantly different ( $P < 0.05$ ).

<sup>e</sup>1 sow died, 1 sow culled before farrowing.

The endocrine data available from the first experiment also indicated that plasma estrogen concentrations in animals treated with 10 µg/kg b. wt. were comparable, but still in the upper range of the peak endogenous levels seen in controls prior to observed estrus. However, compared to the variable times post-weaning at which peak estradiol levels were seen in controls, in OB-treated animals peak plasma estradiol concentrations occurred 8 hours postinjection, suggesting that strict synchrony of subsequent endocrine events and ovulation would be achieved as reported previously for animals treated with OB (Edwards and Foxcroft, 1983).

Completely acyclic sows were found at slaughter in all three treatment groups indicating, in agreement with results previously obtained by Dyck (1976), that animals which are destined to become totally anestrus cannot be stimulated to ovulate by estrogen treatment alone.

In Experiment 2 all three treatments significantly reduced the weaning to estrus interval, despite the mean time to return to  $4.53 \pm 0.25$  days in the controls which in itself represents a good herd average (cf. Burger, 19521).

Assuming that the use of estrogen either alone, or in combination with P.G. 600®, will also produce precise synchronization of the pre-ovulatory LH surge and hence ovulation (see Edwards and Foxcroft, 1983), these data further demonstrate the potential of this method for developing a treatment protocol consistent with the use of fixed-time AI or natural service in the weaned sow.

Conception rates were acceptable and comparable between groups, indicating that treatment did not impair this aspect of fertility. Indeed, treatment with P.G. 600® alone significantly increased the number of piglets born live in agreement with other studies using either P.G. 600® (Schilling and Cerne, 1972; Breeuwisma, 1976) or PMSG (Longenecker and Day, 1968). Although the number of live piglets born to OB-treated sows was not significantly different from pre-treatment values, OB appeared to limit litter size compared to control animals and this effect was not negated by prior treatment with P.G. 600® at the time of weaning. The slight increase in numbers born live post-treatment in the control animals, when

compared to pre-treatment values, is considered to reflect the change from fourth to fifth parity (see English et al., 1977).

The apparent limitation of live litter size in OB-treated animals may, however, to some extent be an aberration of the analytical criteria used: All animals with a weaning to estrus interval greater than 10 days were omitted from statistical analysis and in the control and P.G. 600® alone groups, data from such animals would not, therefore, be included. However, OB treatment will induce estrus even in sows that would potentially be anestrus for longer than 10 days and data from such animals would therefore be included in the analysis; such animals probably have diminished follicular development and a limited number of ovulations.

The weaning to estrus interval after the post-treatment farrowing were normal in all groups, suggesting that the treatments used have no residual adverse effect on estrous activity.

Comparing the results obtained from both experiments, therefore, treatments with either PMSG/HCG or exogenous estrogen successfully reduced the weaning to estrus interval. Although the endocrine events associated with P.G. 600® treatment are not fully understood, it is unlikely that ovulation would be strictly synchronized, whereas estrogen treatment would be expected to produce strict synchronization of ovulation and would thus facilitate the application of a fixed-time AI program. Treatment with OB, even at a dose of 10 µg/kg b. wt., still however appears to result in a limitation of potential litter size, whereas in this study the administration of P.G. 600® alone significantly increased the numbers born live post-treatment. Although there are immediate limitations to the use of either treatment therefore, further investigations of the use of these exogenous compounds appear to offer a real potential for developing a practicable fixed-time insemination system for use in the management of the weaned sow.

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