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Boar effects and their relations to fertility and litter size in sows

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Abstract

Twenty Large White boars and 60 sows were used in two experiments for this study. In experiment 1, 20 sows were assigned per group to each of three treatments, twice daily for a 30-min period during a 4-wk observation, involving: (1) NBE, a control in which sows were not exposed to boars during oestrus detection; (2) FBE, in which sows were exposed to fence-line boars during oestrus detection and (3) PBE, in which sows received physical contact with the boar during oestrus detection. In experiment 2, semen were collected at 24- or 96-h intervals from each boar and used (3.5×10^9 sperm/100 mL/sow) to artificially inseminate three oestrus-synchronised sows, 24 h after the onset of oestrus, for four weeks. Boar exposure for 4 d before oestrus induction (PG600) increased the proportion of sows expressing oestrus within 7 d by 44% with 88.3 ± 5.5% farrowing rate in the PBE group with the shortest interval from PG600 to oestrus (3.5 ± 0.2 d), number of returns to oestrus (0.01 ± 0.02) and farrowing-farrowing interval (136 ± 0.01 d). On average, 45.8 ± 2.5% of the control NBE group of the sows showed spontaneous oestrus compared to 56.3 ± 1.9 *vs*. 88.5 ± 0.7% of FBE and PBE groups, respectively. Ejaculates collected on the 96-h intervals had larger volumes (288 ± 9.3 *vs*. 124.9 ± 5.7 mL), sperm motility (87.1 ± 3.3 *vs*. 55.2 ± 0.9%) and type of movement (8.7 ± 0.5 *vs*. 3.0 ± 0.1), live sperm (78.3 ± 9.6 *vs*. 57.9 ± 12.6.), sperm/mL (132.6 ± 8.1 *vs*. 90. 4 ± 12.1 $x10^6$), total sperm/ejaculate (83.2 ± 7.7 *vs.* 52.5 ± 4.6 $x10^9$) and normal acrosome (92.5 ± 18.4 *vs*. 55.5 ± 15.6%) than ejaculates collected on the 24-h intervals. Semen collected at 96-h had gave higher non-return rate (93.5 ± 2.9 *vs*. 76.8 ± 5.2 %), farrowing rate (85.5 ± 14.3 *vs*. 56.8 ± 9.1%,), litter size (12 ± 0.03 *vs*. 8 ± 0.02) and live piglets were 30% higher compared with those from sows inseminated with semen collected at 24-h intervals, respectively. Results suggest that direct exposure of boars to sows prior to semen collection enhances oestrus expressions and farrowing rates. Secondly, ejaculating boars at 96-h intervals enhances semen quality and quantity leading to significant improvement in the fertility and litter size of artificially inseminated sows.

Keywords: Boar exposure, ejaculation frequency, semen viability, fertility, litter size
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Introduction

It is speculated that boar (male) effect which is referred to as biostimulation (Hughes, 1998; Paterson *et al*., 2002) and ejaculation frequency (Umesiobi & Iloeje, 1999; Willenburg *et al*., 2003; Umesiobi, 2007, 2008a; b) account for much of the variability in fertility and litter size in artificial insemination (AI) sows. The presence of males hastens the onset of puberty in female rats (Johnson & Neaves, 1983), ewe lambs (Umesiobi *et al*., 1998) and gilts (Langendijk *et al*., 2000; Foote, 2003). Male contact with females induces a rapid increase in the frequency of plasma LH pulses, culminating in a preovulatory LH surge and ovulation (Foote, 2003; Breen *et al*., 2005; Rivas-Munoz *et al*., 2007).

Although, it is speculated that it is much easier to heat-check sows by fence-line boar contact instead of placing the boar in the sow pen for full boar contact (Koketsu *et al*., 1999; Paterson *et al*., 2002), fence-line contact with a boar is inadequate to stimulate puberty in most sows. In addition, full boar contact is needed when sows are taken to a high stimulation area that only houses boars (Umesiobi & Iloeje, 1999; Willenburg *et al*., 2003; Umesiobi, 2007).

Presumably, a boar associated with a high fertility rate and large litters consistently produces inseminations that contain sufficient numbers of spermatozoa capable of completing all of these tasks (Koketsu *et al*., 1999; Willenburg *et al*., 2003). However, Flowers (2002) stated that for best results an interval of five to six days is desirable but vigorous boars can be ejaculated once a day. Umesiobi & Iloeje (1999) recommended that young and naïve boars should not be used more often than once a week. Dziuk

(1996) recommends a 4-day semen collection interval for immature and two to three times a week collection for mature boars.

To test the above inferences, the objectives of this study were (1) to determine the effect of method of boar exposure on oestrus expressions and farrowing rates, and (2) to evaluate the effect of ejaculation frequency on semen quality, fertility rate and litter size in sows.

Materials and Methods

Between March 2008 and February 2009, 20 Large White boars (average age 18 months) and 60 sows (of the same age and breed) were used in two experiments to conduct this study at a private pig unit at Rodenbeck, Bloemfontein, South Africa.

In experiment 1, 20 sows were assigned per group to each of three treatments, twice daily (08:30 to 09:00 and 16:00 to 16:30) for a 30-min period during a 4-wk observation, involving: (1) no boar exposure (NBE), a control in which sows were not exposed to boars during oestrus detection; (2) fence-line boar exposure (FBE), in which sows were exposed to fence-line boars during oestrus detection and (3) physical boar exposure (PBE), in which sows received physical contact with the boar during oestrus detection, to evaluate the effects of method of boar exposure to sows on oestrus expressions and farrowing rate. The boar pens were located 6.5 m away from the sow pens, and boars were separated from the sows by a screen to reduce visual, auditory, and olfactory contact between sows and boars.

Following 4 d application of boar exposure protocols to each sow treatment group, oestrus was synchronised in the experimental sows by a single subcutaneous injection of P.G. 600® (400 IU PMSG with 200 IU HCG/5 mL dose/animal; Intervet Inc., Millsboro, DE). After the onset of oestrus, sows on each treatment were artificially inseminated using semen from the same boars and collections. All experimental females received inseminations of 3.5×10^9 sperm/80 mL at 24 h after onset of oestrus.

In experiment 2, the boars were allotted at random to two semen collection schedules: (I) single ejaculates collected for 16 wk at 24-h intervals; and (II) single ejaculates at 96-h intervals for 16 wk. Each ejaculate was examined for volume, progressive sperm motility, live sperm, sperm concentration per milliliter, total sperm per ejaculate, and acrosomal morphology using the procedures of Foote (2003) and Umesiobi (2007). Semen from the last four ejaculates from each of the 24 and 96-h frequency was used to artificially inseminate the sows during their first and second oestrus after weaning.

Data on semen viability were analysed using the general linear model procedure of Statistical Analysis System, Version 9.1 (SAS, 2002). Fertility estimates were tested by Chi-square analysis (Snedecor & Cochran, 1980). Differences between treatment means were tested for significance (SAS, 2002).

Results and Discussion

Table 1 Least square means (± s.e.) for effects of duration of boar exposure through either no contact (NBE), fence-line contact (FBE) or direct contact (DBE) on oestrus, duration of oestrus, and ovulation rate in sows

Item	Methods of boar exposure		
	NBE	FBE	PBE
No. of sows	20	20	20
PG600 to oestrus (d)	$4.6^a \pm 0.3$	$4.6^a \pm 0.3$	$3.5^b \pm 0.2$
Onset of oestrus (%)	$45.8^a \pm 2.5$	$56.3^b \pm 1.9$	$88.5^c \pm 0.7$
Duration of oestrus (h)	$55.2^a \pm 0.3$	$48.6^b \pm 0.3$	$43.5^c \pm 0.1$
Weaning-to-oestrus interval (day)	$5.3^a \pm 0.5$	$4.1^b \pm 0.3$	$1.0^c \pm 0.3$
No. of returns to oestrus per sow	$0.3^a \pm 0.1$	$0.2^b \pm 0.02$	$0.01^c \pm 0.02$
Farrowing-to-farrowing interval (days)	$152^a \pm 0.1$	$145^b \pm 0.01$	$136^c \pm 0.01$
Farrowing rate (%)	$50.4^a \pm 11.7$	$62.9^b \pm 3.5$	$88.3^c \pm 5.5$

[a, c] Means with different superscripts in a row are significantly different ($P < 0.05$).

The number of sows that showed oestrus depended on the method of boar exposure sows received per day (P <0.05). Applying different methods of boar exposure during oestrus detection increased the number of sows expressing a standing response (Table 1). Physical boar exposure (PBE) for 4 d before PG600 increased (P <0.05) the proportion of sows expressing oestrus within 7 d by 44%, shortened (P <0.05) the interval from PG600 to oestrus (43.5 ± 0.1 *vs*. 48.6 ± 0.3 h) compared with FBE. On average, 45.8 ± 2.5 of the control NBE group of the sows showed spontaneous oestrus compared to 56.3 ± 1.9 *vs*. 88.5 ± 0.7% of FBE and PBE groups respectively. The highest proportion of sows observed with onset of oestrus was detected in the PBE experimental group. Further, highest farrowing rates (88.3 ± 5.5%) were recorded from the PBE sow group compare with 6.1 ± 4.2% and 44.5 ± 0.4% obtained from FBE and NBE sow groups, respectively.

This study confirms earlier results that a higher level of boar stimuli during oestrus detection increases the chance of evoking a standing response (Kemp *et al*., 2005; Umesiobi, 2007; 2008a) and farrowing rates. This result was expected, and may be explained by the fact that even with physical boar exposure as the sole stimulus for oestrus induction, variation in the oestrous response is observed amongst treatments (Langendijk *et al*., 2000; Paterson *et al*., 2002).

Table 2 Least square means (± s.e.) for semen viability of boar semen following frequency (24- or 92-h intervals) of ejaculation

	Frequency of ejaculation (h)	
	24	92
Semen volume (mL)	124.9^{a} ± 5.7	288^{b} ± 9.3
Sperm motility (%)	55.2^{a} ± 0.9	87.1^{b} ± 3.3
Type of movement (0-10)	3.0^{a} ± 0.1	8.7^{b} ± 0.5
Live sperm (%)	57.9^{a} ± 12.6	78.3^{b} ± 9.6
Sperm conc./mL ($x10^{6}$)	$90.\ 4^{a}$ ± 12.1	132.6^{b} ± 8.1
Total sperm/ejaculate ($x10^{9}$)	52.5^{a} ± 4.6	83.2^{b} ± 7.7
Normal acrosome morphology (%)	55.5^{a} ± 15.6	92.5^{b} ± 18.4

[a, b] Means with different superscripts in a row are significantly different (P <0.01).

For experiment 2, semen characteristics of the last four ejaculates collected on the 24 and 96-h schedule, respectively are shown in table 2. Ejaculates collected at the 96-h intervals had larger volumes (288 ± 9.3 *vs*. 124.9 ± 5.7 mL), sperm motility (87.1 ± 3.3 *vs*. 55.2 ± 0.9%), progressive sperm movement (8.7 ± 0.5 *vs*. 3.0 ± 0.1), live sperm (78.3 ± 9.6 *vs*. 57.9 ± 12.6), sperm concentration per milliliter (132.6 ± 8.1 *vs*. 90. 4 ± 12.1 $x10^{6}$), total sperm per ejaculate (83.2 ± 7.7 *vs*. 52.5 ± 4.6 $x10^{9}$) and normal acrosome morphology (92.5 ± 18.4 *vs*. 55.5 ± 15.6%) than ejaculates collected on the 24-h intervals at P <0.01.

These results are in accord with an earlier report by Umesiobi *et al*., (2002) who observed that moderate ejaculation frequency, produces highly motile sperm cells, resulting in optimum conception in the female. It is therefore, probable that factors such as time of insemination, uterine environment and nutritional deficiencies (Flowers, 2002) were obviated through the beneficial effects of providing adequate resting period in-between ejaculations, hence, the survival of spermatozoa *in vitro*.

The mean farrowing rate between sows inseminated with semen collected at 24-and 96-h intervals were 56.8 ± 9.11 *vs*. 85.5 ± 14.3% (P <0.01). Litter size varied significantly (P <0.05) between sows inseminated with semen collected at 24-and 96-h intervals (8 ± 0.02 *vs*. 12 ± 0.03) and live piglets from the sows inseminated with semen collected at 96-h were 30% higher than those from sows inseminated with semen collected at 24-h intervals. These results, indicating a direct sire effect on fertility and litter size, are in agreement with results reported by Paterson *et al*. (2002) and Soede *et al*. (2007).

Table 3 Least square means (± s.e.) for effects of frequency of ejaculation at either 24- or 92-h intervals on non-return rate, farrowing rate and litter size in sows

	Frequency of ejaculation (h)	
	24	92
No of sows	30	30
Non-return rate (%)	$76.8^{a} \pm 5.2$	$93.5^{b} \pm 2.9$
Farrowing rate (%)	$56.8^{a} \pm 9.1$	$85.5^{b} \pm 14.3$
Litter size (No./litter):		
Total piglet	$8^{a} \pm 0.02$	$12^{b} \pm 0.03$
Live piglets	$4^{a} \pm 0.1$	$12^{b} \pm 0.02$

[a, b] Means with different superscripts in a row are significantly different ($P < 0.01$).

Conclusions

Results suggest that sow response to stimuli was maximal when boars were physically exposed to sows, compare to fence-line or no boar exposure. Full boar exposure was needed for full expression of oestrus, and farrowing rates, with reduction in weaning-to-oestrus interval and number of returns to oestrus per sow. Boars in the 92-h groups produced semen with the highest semen quality and quantity, and the largest number of piglets per litter with the greatest proportion piglets farrowed alive. The full boar exposure to sows prior to semen collection as well as 92-h intervals of semen collection prior to AI improved fertility and litter size in sows.

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