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Relevance of ovarian follicular development to the seasonal impairment of fertility in weaned sows

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ABSTRACT

A field study was conducted to estimate seasonal differences in follicular development in weaned sows and to evaluate the implication of these differences on seasonal infertility. A total of 110 sows were selected at weaning during winter–spring (WS, $n = 58$) and summer–autumn (SA, $n = 52$). Ovaries were scanned once daily from weaning to the onset of oestrus and twice daily from then until ovulation. Six sows during WS were removed from study for not showing growing follicles at weaning. Oestrus was evaluated twice daily from day 1 after weaning to day 14 post-weaning. One of 52 (1.9%) sows in WS and 9/52 (17.3%) in SA showed no signs of oestrus within 14 days of weaning ($P < 0.05$). The diameters of the follicles at weaning, at the onset of oestrus and just before ovulation were smaller ($P < 0.01$) in SA sows than in WS sows. There were fewer follicles in SA sows than in WS sows just before ovulation ($P < 0.05$). Fifty of 51 (98.0%) sows in WS and 31/43 (72.1%) sows in SA experienced a weaning-to-oestrus interval (WOI) of 3–6 days ($P < 0.05$). Fifty-one of 52 (98.1%) sows in WS and 43/52 (82.7%) sows in SA were inseminated; the percentage of pregnant sows that failed to farrow was lower in WS (1/51, 2.0%) than in SA (5/43, 11.6%; $P < 0.05$). The percentage of farrowed sows was greater in WS (46/51, 90.2%) than in SA (32/43, 74.4%; $P < 0.05$). Sows in WS had on average 1.5 more piglets than sows in SA ($P < 0.05$). Sows with a WOI of 3–6 days had lower rates of pregnancy losses ($P < 0.05$) and higher farrowing percentages ($P < 0.01$) than those with a WOI > 6 days, irrespective of season.

Introduction

The loss of reproductive efficiency in breeding herds is one of the major economic problems of the pig industry. 'Seasonal infertility', defined as a moderate decrease in fertility outcomes in sows throughout the later summer and early autumn (seasonal infertility period), remains one of the most important factors limiting productivity in many countries (Bertoldo et al., 2012). Seasonal infertility is primarily a photoperiod-driven phenomenon enhanced by the high ambient temperature typical of summers in temperate regions of the world (Auvigne et al., 2010). More severe seasonal infertility in sows is therefore found in hotter countries such as Spain (Dominguez et al., 1996) and Australia (Love et al., 1993).

Seasonal infertility leads to decreased farrowing rates and, at times, reduced litter sizes (Bertoldo et al., 2012). Of the various reproductive disorders, a prolonged weaning-to-oestrus interval (WOI) and a higher incidence of pregnancy losses are considered to be key manifestations of seasonal infertility in weaned sows (Peltoniemi and Virolainen, 2006). Depressed ovarian activity could be an underlying manifestation of seasonal infertility and may contribute to the increase in frequency of these reproductive disorders (Love et al., 1993). However, published reports are still limited, and most of the data comes from abattoir studies (Bertoldo et al., 2010, 2011b). Bertoldo et al. (2012) recommended further studies to investigate the ovarian dysfunction underlying reproductive disorders experienced by weaned sows undergoing seasonal infertility. Little is known about the effects of ovarian follicular growth dynamics on the reproductive manifestations of seasonal infertility.

The dynamics of ovarian activity in sows can be monitored using transrectal ultrasonography for short periods of time (4–6 h) without causing stress or disturbing the normal function of the ovaries (Kauffold and Althouse, 2007). Transrectal ultrasonography is a valuable tool for measuring the size and counting the number of growing follicles (Soede et al., 1998; Bolarin et al., 2009). Using tape records of transrectal ultrasonographic images of the ovaries of weaned sows, the aims of the present field study were to estimate seasonal differences in follicular development and to evaluate the potential implications of these differences on the reproductive clinical manifestations of seasonal infertility.

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Materials and methods

Farm location and climatic data

The study was carried out in a large commercial indoor pig breeding unit (1850 breeding sows) owned by Agropor Pig Company and located in the South-East of Spain (37°59′NL, 1°08′WL). Climatic data were obtained from the Spanish State Agency of Meteorology.[1] The natural day length ranged from 14 h 54 min light during the summer solstice to 9 h 30 min light during the winter solstice. Maximum outside air temperatures ranged from 16.5 °C in January (mid-winter) to 34.3 °C in August (mid-summer). The minimum air temperature ranged from 3.8 °C in January to 19.5 °C in August. The relative humidity was always >50% and ranged from 51% in July to 69% in December. The hours of sunlight ranged from 172 h in January to 338 h in July.

Animals and breeding management

The farm had a consistent history of seasonal infertility shown by an increased rate of return to oestrus and reduced farrowing rates and litter sizes in the summer and early autumn. A total of 58 and 52 healthy crossbred (Landrace x Large White) sows (parities 1–6) were randomly selected at weaning (8–10 sows every 2 weeks) from February to March (winter–spring period, WS) and from July to September (summer–autumn period, SA), respectively. The records (mean ± standard error of the mean, SEM) related to previous parity (3.2 ± 0.2 for WS sows, 3.6 ± 0.2 for SA sows; $P = 0.207$), litter size (total piglets born 12.1 ± 0.2 for WS sows, 12.2 ± 0.3 for SA sows; $P = 0.997$) and the length of final lactation (25.1 ± 0.4 days for WS sows, 23.9 ± 0.4 days for SA sows; $P = 0.059$) were similar in both groups of sows.

The sows of both groups had similar body condition scores (BCS; 3.5 ± 0.1 for WS sows, 3.4 ± 0.1 for SA sows; $P = 0.341$) on a scale of 1 (emaciated) to 5 (over fat) (Coffey et al., 1999). Immediately after weaning, the sows were relocated to individual crates in a non-climate controlled large gestation room exposed to natural daylight. The sows had ad libitum access to water and were fed a commercial diet (16% crude protein and 12.2 MJ metabolisable energy per kg dry matter) twice a day at 3.0 kg/day (WS) and 2.5 kg/day (SA).

Oestrus detection was performed twice a day (07.00–08.00 h and 18.00–19.00 h) by trained farm technicians beginning on the day after weaning. Four sows in their crates were checked at any one time for signs of oestrus using the backpressure test for approximately 5–7 min during nose-to-nose contact with a mature boar located in the alley way in front of the crates. The time of onset of oestrus was defined as 6 h before the first time the sows showed a standing response. Oestrus detection was continued until day 14 post-weaning; sows that had shown no signs of oestrus by that time point were defined as anoestrus.

Sows in oestrus were post-cervically inseminated at 12 h and 36 h after the onset of oestrus with a commercial dose of 1.5×10^9 sperm extended in 40 mL Beltsville Thawing Solution. The insemination doses comprised a mixture of semen from multiple boars produced by the artificial insemination centre of the same pig company; doses had ⩾75% motile sperm and <30% morphologically altered sperm. The inseminated sows were exposed once a day to teaser boars from days 18–28 after the onset of oestrus to identify potential returns to oestrus. Pregnancy was confirmed by trans-abdominal ultrasonography at day 28 after insemination. Pregnant sows were monitored until term for abortions, farrowing and number of piglets born.

Transrectal ultrasonography of ovaries

Ovaries were visualised with a portable ultrasound machine (LOGIQ Book XP; GE Healthcare) equipped with cine-loop and fitted with a transrectal 4–10 MHz multiple scan linear transducer (i739-RS, GE Healthcare). The transducer was introduced 35–45 cm beyond the anal sphincter to where the ovaries could be detected. Ovaries were scanned once a day from weaning to the onset of oestrus and twice daily (every 12 h) from then until ovulation. In each sow, both ovaries were scanned in different cross-sections and all of the images were recorded and played later for frame-by-frame viewing, digitising and data collection.

Spherical anechogenic structures with thin borders and occasional irregular outlines were counted as follicles. The diameter of the follicles was measured using the calibrated measurement functions of the ultrasound machine software; structures with diameters >11 mm were assumed to be cysts. The start of ovulation was recorded when the follicle count was noticeably lower than the count of the previous scanning. Circular, homogeneous and hypo-echoic structures were identified as corpora lutea.

Statistical analysis

Statistical analyses were performed using the SPSS 19 (IBM). A χ^2 test or Fisher's exact test was used when appropriate to evaluate the differences in percentages of sows in anoestrus, returns to oestrus, pregnancy disruptions and farrowing between sows in the WS and SA groups. The χ^2 test was also used to evaluate differences in the frequency distribution of WOIs (3–6 days and >6 days) and in the oestrus-to-ovulation intervals (OOIs) among sows. The differences in the size and number of follicles, pregnancy length and number of piglets born per litter were analysed using Student's *t* test. Spearman's nonparametric correlation test was used to calculate the relationships between follicular diameter and WOI length. Differences were considered to be significant at $P < 0.05$.

Results

Follicular growth and follicle number

The ovaries of six of the 58 sows in the WS group had no growing follicles at weaning, but did have corpora lutea ($n = 2$) or single follicular cysts ($n = 4$). The ovaries of all 52 sows in the SA group had growing follicles at weaning. Therefore, a total of 52 sows were scanned for follicular growth and follicle numbers in each of the WS and SA groups. The ovaries of 10 sows had growing follicles 2–5 mm in diameter at weaning, but no follicles that increased to >5 mm diameter during the subsequent 14 days. None of these sows showed signs of oestrus and therefore were classified as anoestrous. Of the 10 sows, only one was recorded in the WS group, whereas nine were recorded in the SA group ($P = 0.016$).

Follicular growth from weaning until ovulation shown by sows exhibiting signs of oestrus is illustrated in Fig. 1. Mean follicular diameter differed between WS and SA sows at weaning ($P = 0.001$), at the onset of oestrus ($P = 0.001$) and immediately before ovulation ($P = 0.009$); WS sows had the largest follicles

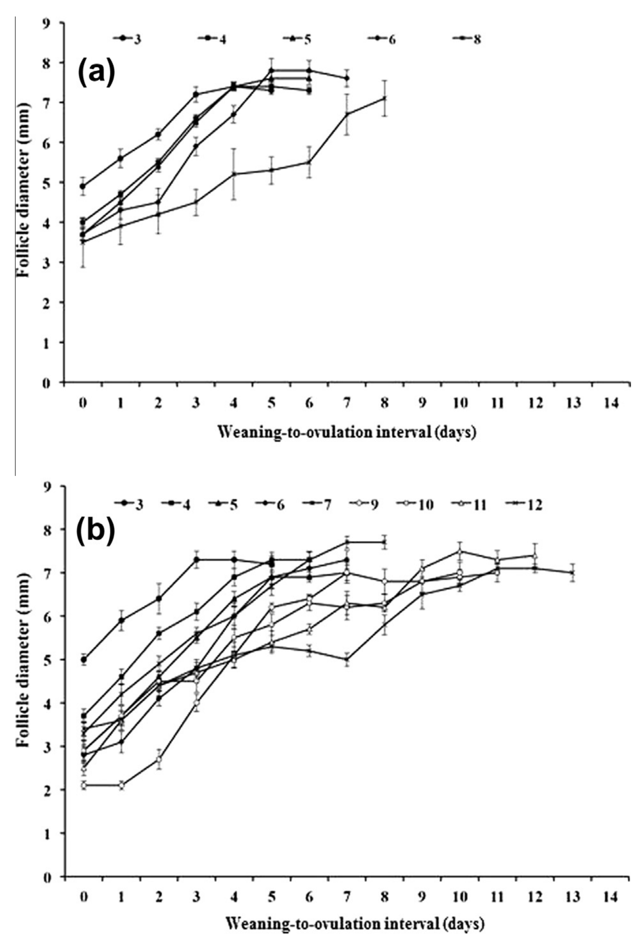

Fig. 1. Ovarian follicular growth from weaning to ovulation in sows displaying signs of oestrus during (a) winter–spring (WS) and (b) summer–autumn (SA). Sows were grouped according to the weaning-to-oestrus interval (WOI).

[1] See: www.aemet.es.