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Reproductive performance of sows associated with single, fixed-time insemination programs in commercial farms based on either average herd weaning-to-estrus intervals or postweaning estrous activity

D. S. Dillard* and W. L. Flowers,† PAS
Department of Animal Science, North Carolina State University, Raleigh 27695-7621

ABSTRACT

Objective: Three separate studies were conducted to determine the effectiveness of adjusting the timing of triptorelin (Ovugel, United Animal Health, Sheridan, IN) administration based on historical weaning-to-estrus intervals (Exp. 1), the occurrence of proestrus (Exp. 2), or the occurrence of estrus (Exp. 3) on reproductive performance of weaned sows.

Materials and Methods: All studies were conducted on commercial farms in eastern North Carolina during the summer months when both the length and variation associated with weaning-to-estrus intervals for sows were increased. In Exp. 1, sows were assigned at weaning to receive triptorelin at either 96 ± 6 h (n = 196) or 120 ± 6 h (n = 196) followed by a single insemination 22 ± 2 h later. Sows bred once each day of estrus (n = 398) served as the control treatment. In Exp. 2, sows were given boar exposure beginning on d 3 after weaning and at proestrus were assigned to 1 of 2 treatments: (1) control (n = 301), which were bred once each day of detected estrus, or (2) triptorelin (n = 296) followed by a single insemination 22 ± 2 h later. In Exp. 3, sows were given boar exposure beginning on d 3 after weaning, and those detected in estrus on d 4 or 5 were assigned to be bred once each day of estrus (control d 4, n = 98 and control d 5, n = 118) or treated with triptorelin (d 4, n = 97 and d 5, n = 117) followed by a single insemination 22 ± 2 h later.

Results and Discussion: Reproductive performance was significantly reduced ($P \leq 0.05$) when triptorelin was given at a fixed time after weaning irrespective of estrous status compared with the control sows that were bred once each day of estrus (Exp. 1). This was due to the subset of treated sows that were not in estrus when they were bred. In contrast, weaned sows treated with triptorelin at either proestrus or estrus and bred once 22 ± 2 h later had similar reproductive performance ($P \geq 0.63$) compared with their counterparts bred once each day of estrus.

Implications and Applications: Use of either proestrus or estrus as the criterion for intravaginal administration of triptorelin and the subsequent fixed-time AI in herds with extended or variable weaning-to-estrus intervals was effective in terms of maintaining reproductive performance equivalent to conventional AI strategies.

Key words: swine, fertility, artificial insemination

INTRODUCTION

Ovugel (United Animal Health, Sheridan, IN) recently became the first pharmaceutical available in the United States for single, fixed-time AI in swine (Knox et al., 2018). It contains the gonadotropin-releasing hormone agonist triptorelin in a proprietary gel formulation that is administered intravaginally to sows at 96 ± 6 h after weaning followed by insemination 22 ± 2 h later. The rationale behind this is as follows: average weaning-to-estrus intervals for most herds are between 4 and 5 d (Weitze et al., 1994; Knox et al., 2001; Belstra et al., 2004); ovulation occurs, on average, at 43.0 ± 1.5 h after triptorelin is administered (Stewart et al., 2010); and fertility in sows is highest when they are bred during the 24-h period before ovulation (Kemp and Soede, 1996; Soede and Kemp, 1997). Based on these observations, it seems reasonable that this approach should produce fertility results as good, if not better, than conventional breeding strategies, which involve insemination of sows once each day of estrus. However, recent reports indicate that there is significant variation in reproductive performance within and among herds that have evaluated intravaginal administration of triptorelin and fixed-time AI (Flowers et al., 2013; Knox et al., 2018). Several factors influence how quickly sows return to estrus after weaning, and this likely is the main

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*Current address: DNA Genetics, 2415 13th Street, Columbus, NE.
†Corresponding author: william_flowers@ncsu.edu

reason for this inconsistency. These include parity, genetics, nutrition, ambient temperature, and cross-fostering and weaning strategies (Aherne and Kirkwood, 1985; Soede et al., 2009; Rempel et al., 2017). Administration of triptorelin based on the estrous activity of either an entire weaning group or individual sows within a group are 2 modifications that may prove effective for addressing the inherent variation in weaning-to-estrus intervals and, thus, the observed variable fertility results on commercial farms. Therefore, 3 separate studies were conducted to determine the effectiveness of adjusting the timing of triptorelin treatment based on historical weaning-to-estrus interval data for a herd (Exp. 1), the occurrence of proestrus (Exp. 2), or the occurrence of estrus (Exp. 3) on conception rate, farrowing rate, and birth litter characteristics. In each study, the control treatment was the conventional AI regimen that involved insemination of a contemporary group of sows once each day of estrus.

MATERIALS AND METHODS

All studies were conducted on commercial sow farms located in eastern North Carolina between July and September of 2016. Routine animal care was provided by farm personnel and followed each farm's standard operating procedures. All farms were Pork Quality Assurance Plus certified (National Pork Board, 2019) and passed an external third-party animal welfare audit. The experimental breeding regimens involving Ovugel were approved by the North Carolina State University Institutional Animal Care and Use Committee (NCSU 16-111-A).

Exp. 1: Adjusting Administration of Triptorelin Based on Weaning-to-Estrus Interval

The first study was conducted on two 2,400-head commercial sow farms that followed a 4-wk batch production schedule. Genetics, facilities, and standard operating procedures were similar on both farms, which were located approximately 52 km from each other. Barns for breeding and gestation were curtain-sided, tunnel-ventilated buildings with a pit-recharge system for waste removal. Sows were housed in the same stall (0.9 m × 1.9 m) after weaning until they were moved into farrowing at 110 d after insemination. Each stall was equipped with a drop feeder and nipple waterer. All sows were fed once daily with a corn–soybean meal gestation diet formulated to meet the nutritional needs of sows as follows: estimated breeding weight of 181 kg, gestation weight gain of 52 kg, and total born of 13 piglets (NRC, 2012). Sows received 1.8 kg of feed between d 0 and 30 of gestation, between 1.8 and 2.3 kg of feed between d 31 and 90 of gestation depending on their estimated body condition, and an additional 0.5 kg from d 90 to the end of gestation. Farrowing rooms were solid walled with an end-wall baffle ventilation system and a deep pit for waste removal. The farrowing environment consisted of a bow-bar crate (0.8 m × 2.1 m) with 0.5 m × 2.1 m piglet areas located on each side and woven wire flooring. Each crate was equipped with a trickle feeder, 2 nipple waterers (one for the sow and one for the piglets), and a heat lamp connected to a thermostat. A corn–soybean meal diet was fed ad libitum during lactation and formulated to meet the nutritional needs of the sows with the following criteria: postfarrowing weight of 175 kg, anticipated weight loss during lactation of 10 kg, and piglet ADG of 200 g (NRC, 2012).

The July and August weaning groups on each farm were used for the study. These occurred during the first and third week of each month for these 2 farms, respectively. Average weaning-to-estrus intervals over the previous 3 yr for sows weaned during the summer months in both farms were 5.9 ± 0.7 d. At weaning crossbred sows composed of Yorkshire, Large White, and Landrace breeds were assigned randomly within parity group (parities 1–2 or parities 3–6) to receive 1 of 3 breeding treatments: (1) control, (2) triptorelin intravaginally at 96 ± 6 h after weaning, or (3) triptorelin intravaginally at 120 ± 6 h after weaning. All sows were given daily fence-line contact with a mature boar for approximately 10 min per day beginning on d 3 after weaning while technicians applied the back pressure test to determine the presence of the standing reflex. Control sows were bred once each day of estrus. The average weaning-to-estrus interval for control sows in this experiment was 6.0 ± 0.7 d, which was similar to the historical average for these 2 herds. Triptorelin-treated sows received a single insemination 22 ± 2 h after treatment regardless of their estrous status. All inseminations were done via conventional, intracervical AI with foam-tipped catheters. Five experienced technicians in the first farm and 7 experienced technicians in the second farm performed all inseminations. Insemination doses consisted of 3 billion total sperm pooled from 5 different terminal line boars composed of Duroc, Hampshire, and Spot breeds in 60 mL of a 7-d extender. The average time between collection and insemination was 1.5 ± 0.4 d for both farms. Insemination technicians and semen batches were equally distributed across all treatments in each farm. Pregnancy diagnosis in both farms was performed via real-time ultrasonography between 25 and 32 d after insemination by the same individual. Weekly high and low temperatures were recorded for the breeding/gestation and farrowing barns. During the study, these varied between 28.8 and 21.1°C for the farrowing barns and 27.6 and 17.7°C for the breeding/gestation barns.

Mixed model ANOVA procedures (PROC MIXED) for categorical (conception and farrowing rates; Koch et al., 1977) or continuous data (litter characteristics; Littel et al., 1996) were used to determine statistical differences (SAS, version 9.4, SAS Institute Inc., Cary, NC). The initial model included main effects of treatment, parity group, breeding group, and farm as well as all possible 2-, 3-, and 4-way interactions. Lactation length and number of pigs weaned during the pretreatment lactation were covariates. Farm, breeding group, and their interactions with the other main effects were not significant ($P \geq 0.53$), and there was no interaction between parity group and treatment ($P = 0.32$). Consequently, these variables were removed as main effects in the statistical model, and data were reanalyzed. Student-Newman-Keuls multiple range test was used to determine differences among breeding treatments when a significant main effect was present (Snedecor and Cochran, 1989).

A second analysis was conducted to determine whether estrous status at mating influenced the subsequent fertility of sows treated with triptorelin. These data were analyzed with mixed model procedures similar to those discussed previously with the exception that sows within each triptorelin treatment were further partitioned post priori into 2 groups based on whether they were in estrus at breeding. This created 4 treatment combinations: sows treated with triptorelin at 96 h that were in estrus at insemination; sows treated with triptorelin at 96 h that were not in estrus at insemination; sows treated with triptorelin at 120 h that were in estrus at insemination; and sows treated with triptorelin at 120 h that were not in estrus at insemination.

Exp. 2: Effect of Treatment with Triptorelin at Proestrus

Experiment 2 was conducted in a 2,400-head commercial sow farm that also followed a 4-wk batch production system. This farm was part of the same production system as the 2 farms used in the first experiment, so facilities, genetics, and standard operating procedures were similar to those described previously with 2 exceptions. This farm used postcervical AI for inseminations and moved sows to gestation pens after they were confirmed pregnant with ultrasound. Gestation pens consisted of an open lounging area in the center of the pen with individual feeding stations (freestalls) on the north and south sides of the pens. Each freestall was equipped with a drop feeder so all sows in a pen could be fed at the same time. Two nipple waterers were located on the east and west sides for a total of 4 per pen. Sows confirmed pregnant by ultrasonography between d 25 and 28 after insemination were organized into groups of 16 animals based on size and temperament and moved from stalls to pens. Excluding the freestalls, there was 2.5 m^2 per sow per pen. Feeding strategies were similar to those described previously except feeding levels in mid-gestation were based on the average body condition of all sows in a pen and not on an individual animal.

The postcervical AI procedure was as follows. Detection of estrus began on d 3 after weaning and was provided by moving a boar in a mechanical cart along the alley in front of the sows. The boar cart was maneuvered slowly along the alley as breeding technicians applied back pressure to each sows. About 500 sows were checked daily for estrus, which began at 0730 h and was usually completed by 1000 h. Insemination began at 1300 h and was performed in the absence of boar exposure. Insemination doses consisted of 2.4 billion total sperm pooled from 5 different terminal line sires in 40 mL of a 7-d extender. The average time between collection and insemination of semen was 1.8 ± 0.6 d.

This study was conducted with the July, August, and September batches. The mean weaning-to-estrus interval for sows during these months over the past 2 yr was 6.1 ± 0.7 d. Detection of estrus was performed by the same technician throughout the entire study. Criteria for identification of proestrus were as follows: increased vocalizations and movement toward heat-check boar, reddening and swelling of vulva, and secretion of vaginal mucus with a sticky consistency without exhibiting a firm standing reflex or "ear-popping" response. Sows in proestrus were identified with a red paint mark on their back and within parity groups (1–2 or 3–6) were randomly assigned to 1 of 2 treatments: control or intravaginal administration of triptorelin. Sows were treated with triptorelin between 1500 and 1600 h on the day that they were identified as proestrus and inseminated 22 ± 2 h later. Control sows were checked for estrus the day after they were identified as proestrus, and if they were in estrus, then they were bred that afternoon and again the following day at 3 ± 2 and 24 ± 2 h relative to detected estrus, respectively. In addition, all sows not detected in estrus on d 6 after weaning were treated with triptorelin and bred once the next day at 22 ± 2 h after treatment. This was done in an attempt to keep sows on schedule with their batch and was designated as the triptorelin-anestrus treatment.

Insemination technicians and batches of semen were equally distributed across treatments. If the inner catheter could not be passed successfully through the cervix during insemination, then the sow was removed from the study. Pregnancy diagnosis was performed via real-time ultrasonography between 25 and 28 d after insemination by a single technician. Weekly high and low barn temperatures also were recorded, and these varied between 26.3 and 20.3°C for the farrowing barns and 26.9 and 19.1°C for the breeding/gestation barns.

Mixed model ANOVA procedures (PROC MIXED) for categorical (conception and farrowing rates; Koch et al., 1977) or continuous data (litter characteristics; Littel et al., 1996) were used to determine differences among treatments with SAS (version 9.4, SAS Institute Inc.). The statistical model included the main effects of treatment, parity group, breeding group, and day of proestrus after weaning (d 3, 4, or 5). All possible 2-, 3-, and 4-way interactions among the main effects were also included as additional sources of variation. Lactation length and number of pigs weaned during the pretreatment lactation were used as covariates. Day of proestrus after weaning, breeding group, and their interactions with other main effects were not significant ($P \geq 0.23$), and there was no interaction between parity group and treatment ($P = 0.49$). These variables were removed as main effects and returned to the estimation of the experiment-wise error, and data were reanalyzed with the inclusion of the Ovugel anestrus sows as a third treatment. When a significant main effect of treatment was observed, Student-Newman-Keuls multiple range test was used as the mean separation test (Snedecor and Cochran, 1989).

Exp. 3: Effect of Treatment with Triptorelin at Estrus

The third study was conducted in a 1,200-head commercial sow farm that followed a weekly production schedule. Breeding/gestation barns were curtain-sided, tunnel-ventilated buildings with an under-slat flush system for waste removal. Immediately after weaning sows were housed in stalls (0.9 m × 1.9 m), bred, and then moved to gestation pens at 5 d after insemination. Sows in the stalls were fed by hand, and each stall was equipped with a nipple waterer. Gestation pens consisted of an open lounging area in the center of the pen with individual feeding stations (freestalls) on the east and west sides of the pens. Each freestall was equipped with a drop feeder so all sows in a pen could be fed simultaneously. Two nipple waterers were located on the north and south sides of the pen. Pregnant sows were organized into groups of 12 animals based on size and temperament. Excluding the freestalls, there was 2.1 m^2 per sow per pen. Pregnancy diagnosis was performed at d 30 after insemination while sows were being fed in the freestalls. Farrowing barns were curtain-sided facilities with an under-slat ventilation system and an under-slat flush system for waste removal. The farrowing environment consisted of a centrally located finger crate (0.8 m × 2.1 m) with 0.5 m × 2.1 m piglet areas located on each side with woven wire flooring. Each crate was equipped with a trickle feeder, 2 nipple waterers (one for the sow and one for the piglets), and heat pads connected to a thermostat. Nutritional programs for sows during gestation and lactation were similar to those described previously.

The study was conducted with 8 groups of sows between mid-July and mid-September. The mean weaning-to-estrus interval for sows during July, August, and September over the past 2 yr was 5.7 ± 0.8 d. Detection of estrus began on d 3 after weaning and was provided by moving a boar housed in a mechanical cart in the alley in front of the sows. The boar cart was maneuvered slowly along the alley as breeding technicians applied back pressure to each sows. There were about 150 sows checked daily for estrus between 0630 and 0830 h. Crossbred sows composed of Yorkshire, Large White, and Landrace breeds identified in estrus on d 4 and 5 after weaning within parity groups (1–2 and 3–6) were randomly assigned to control or triptorelin treatments. Control sows were bred once each day of estrus via postcervical AI, which began about 0930 h and was performed in the absence of the boar. Instead of being bred on the first day of estrus (d 4 or 5) triptorelin-treated sows were given triptorelin and received a single insemination 22 ± 2 h later on the following day. Insemination doses consisted of 2 billion total sperm pooled from 5 different terminal line sires composed of Hampshire, Duroc, and Pietrain breeds in 40 mL of a 7-d extender. Detection of estrus and inseminations for the experimental sows were performed by the same 3 technicians throughout the entire study, and batches of semen were equally distributed across treatments and breeding technicians. The average time between collection and insemination of semen was 2.5 ± 0.5 d. Weekly high and low barn temperatures were recorded, and these varied between 28.7 and 20.4°C for the farrowing barns and 26.9 and 16.9°C for the breeding/gestation barns during the study.

Mixed model ANOVA procedures (PROC MIXED) for categorical (conception and farrowing rates; Koch et al., 1977) or continuous data (litter characteristics; Littel et al., 1996) were used to determine differences among treatments with SAS (version 9.4, SAS Institute Inc.). The statistical model included treatment, parity group, and breeding group as main effects with additional sources of variation being the 2-way and 3-way interactions among the main effects. Lactation length and number of pigs weaned during the pretreatment lactation and breeding day were used as covariates. Breeding group and its interactions with other independent variables were not significant ($P \geq 0.17$), and there was no interaction between parity group and treatment ($P = 0.22$). Consequently, these variables were removed as main effects from the statistical model, and data were reanalyzed. When a significant main effect was observed, Student-Newman-Keuls multiple range test was used to determine treatment differences (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Administration of Ovugel to peri-estrous sows (Tables 3 and 4) was more effective from a reproductive perspective compared with treating sows at a fixed time after weaning (Tables 1 and 2). This statement is supported by the observations that conception rates, farrowing rates, total born, and number of pigs born alive for control sows bred once each day of estrus were similar to those for sows given triptorelin at either proestrus ($P \geq 0.78$; Table 3) or estrus ($P \geq 0.63$; Table 4) but significantly greater compared with sows administered triptorelin at either 96 or 120 h after weaning regardless of their estrous status ($P \leq 0.05$; Table 1). Ovugel contains 100 μg of the gonadotropin-releasing hormone agonist triptorelin, which has been shown to induce a luteinizing hormone surge and ovulation in over 90% of weaned sows provided their reproductive system has recovered sufficiently (Sesti and Britt, 1994; Stewart et al., 2010). Physiological and behavioral changes associated with proestrus and estrus are caused by increased secretion of estrogens from preovulatory follicles in response to luteinizing hormone and FSH and are indicative of a functionally competent hypothalamic-pituitary-ovarian axis (Soede et al., 2009). Consequently, it is not surprising that using either of these criteria as

Table 1. Effect of intravaginal administration of triptorelin at 96 or 120 h after weaning on reproductive performance (mean ± SE) of sows (Exp. 1)

	Treatment		
Production variable	**Control**	**Triptorelin, 96 h after weaning**	**Triptorelin, 120 h after weaning**
Number of sows[1]	398	196	196
Lactation length[2] (d)	18.8 ± 0.2	18.8 ± 0.2	18.6 ± 0.2
Conception rate (%)	98.8 ± 2.6^x	90.3 ± 2.1^y	81.0 ± 2.9^z
Farrowing rate (%)	87.9 ± 2.8^x	76.0 ± 3.1^y	65.2 ± 3.4^z
Total number born	13.5 ± 0.2^x	12.8 ± 0.2^y	12.8 ± 0.3^y
Number born alive	13.2 ± 0.2^x	12.5 ± 0.2^y	12.4 ± 0.3^y

$^{x–z}$Means within the same row with different superscripts are different ($P \leq 0.05$).

[1] Number of sows allocated to each treatment at weaning.

[2] Mean lactation length before allocation to treatments at weaning.

reference points for the administration of triptorelin resulted in a high level of fertility comparable to traditional AI programs with multiple inseminations.

The main reason for the reduced reproductive performance when triptorelin was given at a fixed time after weaning was the poor response of sows that were not in estrus when inseminated (Table 2). Every aspect of their reproductive performance was significantly reduced ($P \leq 0.05$) compared with their counterparts that were in estrus. Differences of 30 to 40% for conception and farrowing rates and 0.9 to 1.1 pigs for total born and number born alive were observed regardless of whether triptorelin was given at 96 or 120 h after weaning. In contrast, it appears that the subset of triptorelin-treated sows that were in estrus when inseminated (Table 2) had comparable fertility to control sows (Table 1), although these comparisons were not evaluated statistically.

It is important to note that all 3 studies were conducted during the summer months when increased weaning-to-estrus intervals are common in commercial sow farms (Love et al., 1993; Xue et al., 1994). This phenomenon is caused, in part, by the negative effect that elevated ambient temperature and decreased feed intake have on gonadotropin secretion and the subsequent growth of follicles (Aherne and Kirkwood, 1985; Wettemann and Bazer, 1985; Flowers and Day, 1990). In fact, this was the rationale for delaying triptorelin administration until 120 h after weaning in the first study because the average rebreeding interval in both farms was almost 6 d or 144 h. If the proportion of triptorelin-treated sows in estrus at insemination was representative of a fully functional reproductive system after weaning, then it appears that only 72.4% (142/196) and 61.2% (120/196) of the sows met this criterion at 96 and 120 h, respectively, in the first study. These percent-

Table 2. Effect of estrous status at insemination on reproductive performance (mean ± SE) of sows treated with triptorelin at 96 or 120 h after weaning (Exp. 1)

	Triptorelin, 96 h after weaning		Triptorelin, 120 h after weaning	
Production variable	**Estrus[1]**	**No estrus[2]**	**Estrus[1]**	**No estrus[2]**
Number of sows	144	52	120	76
Lactation length[3] (d)	19.0 ± 0.2^x	18.3 ± 0.2^y	19.0 ± 0.2^x	17.9 ± 0.2^y
Conception rate (%)	98.5 ± 1.0^x	67.6 ± 7.8^y	98.2 ± 2.3^x	53.8 ± 7.0^y
Farrowing rate (%)	87.5 ± 2.8^x	44.2 ± 7.0^y	83.3 ± 3.4^x	36.8 ± 5.6^y
Total number born	13.1 ± 0.2^x	12.0 ± 0.5^y	13.2 ± 0.3^x	12.2 ± 0.4^y
Number born alive	12.7 ± 0.2^x	11.8 ± 0.3^y	12.8 ± 0.3^x	11.7 ± 0.4^y

^{x,y}Means within the same row with different superscripts are different ($P \leq 0.05$).

[1] Sows that were in estrus during insemination following triptorelin treatment.

[2] Sows that were not in estrus during insemination following triptorelin treatment.

[3] Mean lactation length before allocation to treatments at weaning.

Table 3. Effect of intravaginal administration of triptorelin on reproductive performance (mean + SE) when given to sows at proestrus or to anestrous sows at d 6 after weaning (Exp. 2)

	Treatment		
Production variable	Control[1]	Triptorelin at proestrus[2]	Triptorelin at anestrus (d 6)[3]
Number of sows	301	296	141
Lactation length[4] (d)	20.4 ± 0.3	19.9 ± 0.3	20.1 ± 0.4
Conception rate (%)	94.7 ± 2.9^{x}	94.0 ± 3.4^{x}	40.8 ± 6.9^{y}
Farrowing rate (%)	93.8 ± 3.1^{x}	93.4 ± 3.5^{x}	42.9 ± 7.1^{y}
Total number born	14.7 ± 0.2^{x}	14.8 ± 0.2^{x}	13.6 ± 0.4^{y}
Number born alive	13.3 ± 0.2^{x}	13.4 ± 0.2^{x}	12.2 ± 0.4^{y}

^{x,y}Means within the same row with different superscripts are different ($P \le 0.05$).

[1] Sows identified as proestrus and then bred subsequently each day of estrus.

[2] Sows identified as proestrus, treated with triptorelin, and bred once 22 ± 2 h later.

[3] Sows not found in estrus by d 6 after weaning, treated with triptorelin, and bred once 22 ± 2 h later.

[4] Mean lactation length before allocation to treatments at proestrus.

ages are similar to the overall farrowing rates of 76.0 ± 3.1% and 65.2 ± 3.4% for these 2 treatments. Triptorelin-treated sows that were in estrus at insemination had longer lactation lengths ($P \le 0.05$) compared with their counterparts that were not (Table 2). Whether this provided additional recovery time after farrowing certainly is a possibility because a positive association between lactation length and fertility has been reported previously (Mabry et al., 1996; Koketsu et al., 1997). Collectively, these observations provide credence for the argument that a functional reproductive axis at the time of triptorelin administration is necessary to achieve fertility results comparable to conventional AI regimens.

As mentioned previously, the approved use of triptorelin is treatment at 96 ± 6 h after weaning followed by a single insemination 22 ± 2 h later. This is based on the assumption that most farms have average weaning-to-estrus intervals of 4 to 5 d. However, as also mentioned previously, there are several factors that affect the physiology associated with this process. Therefore, it is not surprising that significant variability within and among herds has been observed in terms of how sows respond reproductively to the approved regimen, especially during the summer months. Development of strategies to account for this physiological variation are necessary for many production systems if they choose to use triptorelin and fixed-time

Table 4. Effect of intravaginal administration of triptorelin at estrus on reproductive performance of weaned sows (mean ± SE; Exp. 3)

	Estrus, d 4 after weaning[2]		Estrus, d 5 after weaning[3]	
Production variable[1]	Control	Triptorelin	Control	Triptorelin
Number of sows	98	97	118	117
Lactation length[4] (d)	21.8 ± 0.2	22.0 ± 0.3	21.3 ± 0.2	21.5 ± 0.2
Conception rate (%)	92.5 ± 3.0	93.6 ± 3.8	91.8 ± 2.3	88.8 ± 3.4
Farrowing rate (%)	86.5 ± 3.5	87.4 ± 3.4	86.4 ± 3.2	83.8 ± 3.6
Total number born	14.3 ± 0.1	14.2 ± 0.3	13.6 ± 0.3	13.5 ± 0.4
Number born alive	13.1 ± 0.3	13.0 ± 0.3	12.5 ± 0.3	12.4 ± 0.3

[1] No differences in performance were observed between control or triptorelin-treated sows ($P \ge 0.38$).

[2] Sows in estrus on d 4 after weaning assigned to control or triptorelin treatments.

[3] Sows in estrus on d 5 after weaning assigned to control or triptorelin treatments.

[4] Mean lactation length before allocation to treatments at estrus after weaning.

AI. One way to address this inherent variation while still following the approved usage guidelines would be to check for estrus and treat only sows in proestrus or estrus on d 4 after weaning. Based on the results of the second and third studies, farrowing rate and number born alive should be comparable to breeding sows once each day of estrus with this approach.

In contrast, if a farm is considering use of triptorelin intravaginally at a fixed time without regard to the estrous activity of individual animals, then estimating the proportion of sows that normally are in estrus on d 4 or 5 after weaning should prove useful for determining whether a positive response relative to multiple insemination regimens is likely. Collectively, results from all 3 studies appear to support this statement. Sows in estrus or proestrus on d 4 and treated with triptorelin had excellent fertility comparable to their counterparts bred once daily. These 2 groups of sows would be equivalent to those in estrus on d 4 and 5, respectively, if the assumption is made that proestrus on d 4 should lead to estrus on d 5. In the first study, there also appeared to be a positive relationship between estrus at breeding and fertility in triptorelin-treated sows, so as this proportion increases within a herd, it is reasonable to speculate that so should reproductive performance. With this approach, triptorelin could be given to all sows at 96 ± 6 h but only in herds or, more realistically, breeding groups within herds that historically have a high percentage of sows in estrus on d 4 and 5 after weaning. In this situation, farrowing rates and litter characteristics also should be similar to those achieved with AI regimens using multiple inseminations.

Batch systems are increasing in popularity within the swine industry for a variety of reasons (Bown, 2006). However, they place additional pressure on farms to rebreed sows within 7 to 10 d after weaning. If this does not occur, then sows fall out of their batch and either have to be culled or accumulate nonproductive days waiting to be rebred. Because of its mode of action, Ovugel presumably can stimulate the final stages of follicular growth and ovulation in some sows whose reproductive recovery is taking longer than 4 or 5 d even though this is an extra-label use. When it was used for this purpose during the second study, as expected, farrowing rates and number of pigs born alive were significantly lower ($P \leq 0.05$) compared with control sows and those treated at proestrus (Table 3). Nevertheless, these data represent an estimate of the expected farrowing rate, 42.9 ± 7.1%, and litter size, 12.2 ± 0.4, of weaned, anestrous sows treated with Ovugel and should be useful in helping batch production systems make informed decisions with regard to keeping sows on schedule with this intervention.

APPLICATIONS

Intravaginal administration of triptorelin at either proestrus or estrus followed by a single, timed insemination 22 ± 2 h later resulted in reproductive performance equivalent to inseminating sows once each day of estrus in herds with extended or variable weaning-to-estrus intervals.

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