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Influence of GnRH supplementation at CIDR removal on estrus expression and interval to estrus in beef cattle

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ABSTRACT

Previous research has indicated that multiple small doses of GnRH following CIDR removal increased circulating concentrations of estradiol. Therefore, our objective was to determine if a single small dose of GnRH (5 μg or 10 μg) at CIDR removal would impact expression of estrus and/or interval to estrus. Beef cows and heifers (n = 1620; n = 1057 cows, n = 563 heifers) were synchronized using the 7-day CO-Synch + CIDR protocol, and randomly assigned to one of three treatments (0, 5, or 10 μg of a GnRH analog at CIDR removal). Animals were inseminated following detection in estrus. Interval to estrus was calculated for each animal that exhibited estrus (INTERVAL 1). Animals that did not exhibit estrus were administered 100 μg of GnRH at the time of AI and their interval to estrus was designated at 120 h (INTERVAL 2). There was a treatment by age interaction ($P = 0.05$) on INTERVAL 1. Heifers treated with 5 μg of GnRH tended to have a shorter interval to estrus ($P = 0.07$; 47 ± 1.4 h) compared to 0 μg (50 ± 1.5 h) and did have a shorter interval compared to 10 μg ($P < 0.01$; 52 ± 1.5 h). There were no differences between treatments in interval to estrus among cows ($P > 0.34$). When animals that did not exhibit estrus by 120 h were included in the analysis there was no treatment by age interaction ($P = 0.49$). This is likely due to the fact that treatment ($P < 0.01$), but not age ($P = 0.96$) or treatment by age ($P = 0.74$) influenced expression of estrus. In addition, there tended to be a treatment by estrus interaction ($P = 0.08$) on pregnancy success. There was no difference in pregnancy success between treatments among animals that exhibited estrus ($P > 0.30$). In summary, 5 μg of GnRH at CIDR removal tended to decrease the interval to estrus and increased expression of estrus among heifers but not cows, and 10 μg of GnRH at CIDR removal did not improve estrus expression and lengthened the interval to estrus in comparison to the control.

1. Introduction

Estradiol plays a critical role in fertility among cattle, specifically it has been reported that preovulatory estradiol regulates uterine pH [1], sperm transport [2], and endometrial genes that support processes which set up the uterine environment for implantation [3], all of these favorably impact embryo development and survival. Estradiol is also critical within the ovary as it is associated with activation, growth, divergence, ovulation, and eventual regression/atresia of follicles [4]. Classically, estradiol from the follicle is believed to be produced via the two-cell two-gonadotropin theory [5]. A 5 μg dose of GnRH stimulates an LH pulse similar to a physiological pulse [6], and multiple small doses (5 μg) of GnRH administered systemically following CIDR removal increased circulating concentrations of estradiol [7]; the primary signal to the hypothalamus to initiate estrus behavior [8,9].

Cows and heifers that exhibit estrus prior to fixed-time AI had increased concentrations of estradiol [1] and increased conception rates compared to animals that did not exhibit estrus [10]. Variations in expression of estrus, interval to estrus, and/or pregnancy success have been hindrances to the successful use of protocols to synchronize estrus [11,12]. As a result, investigation in ways to manipulate these protocols to favorably impact expression of estrus, interval to estrus, and/or conception rates presents an imperative area of research. The hypothesis was that animals that received a single small dose of GnRH (5 μg or 10 μg) at CIDR removal would have increased expression of estrus contributing to increased pregnancy success. Therefore, the objective of this study

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was to determine if a single small dose of GnRH (5 μg or 10 μg) at CIDR removal would impact expression of estrus, interval to estrus, or pregnancy success.

2. Materials and methods

All procedures were approved by the South Dakota State University Institutional Animal Care and Use Committee.

2.1. Experimental design

Beef cows and heifers (n = 1620; n = 1057 cows and 563 heifers) from five operations in Minnesota and South Dakota were randomly assigned to one of three treatment groups (0, 5, or 10 μg GnRH analog at CIDR removal as 0, 0.1, and 0.2 mL of Factrel, respectively). Tuberculin syringes were used to administer the 5 μg and 10 μg doses of GnRH. Animals in the 0 μg of GnRH group did not receive any additional injections at time of CIDR removal. All animals were synchronized using the 7-day CO-Synch + CIDR protocol. Animals were administered GnRH (100 μg as 2 mL of Factrel i.m.; Zoetis Animal Health, Parsippany, NJ) on d -7, and a CIDR insert (Zoetis Animal Health, Parsippany, NJ) was inserted intravaginally. On d 0, $PGF_{2\alpha}$ was administered ($PGF_{2\alpha}$; 25 mg as 5 mL of Lutalyse i.m; Zoetis Animal Health, Parsippany, NJ), CIDRs were removed, and GnRH treatments applied (Factrel i.m.; Zoetis Animal Health, Parsippany, NJ). Estrous detection aids (EstroTect; Rockway, Inc., Spring Valley, WI, USA) were applied to the tail head of cows at CIDR removal to aid with estrous detection. Animals were visually observed for estrus at least three times a day for a minimum of 30 min each time and inseminated approximately 12 h following detection in estrus. Animals that did not exhibit estrus were given 100 μg of GnRH at time of AI, 120 h post CIDR removal, and this was recorded as their interval to estrus. Interval to estrus was calculated for each animal that exhibited estrus (INTERVAL 1). When animals that did not exhibit estrus were included in the analysis with animals that did, this was termed INTERVAL 2. Within each location, AI bulls and AI technicians were distributed evenly among the three treatment groups. A period of 7–14 days was maintained before cows/heifers were turned out with clean-up bulls, for all five herds. All cows and heifers from the five respective herds were maintained as single groups throughout the entire experiment. Across the five herds, the breeding season ranged from 60 to 90 days in length.

2.2. Ultrasonography

Pregnancy diagnoses were conducted between 30 and 70 days following artificial insemination via transrectal ultrasonography using an Aloka 500V ultrasound with a 7.5 MHz transrectal linear probe (Aloka, Wallingford, CT), and crown-rump length was used to determine fetal age.

2.3. Statistical analysis

Differences in interval to estrus were analyzed by analysis of variance using the PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). When the F statistic was significant ($P < 0.05$), mean separation was performed using least significant differences (Means ± SEM, [13]). Difference is pregnancy success between treatments were analyzed as binomial distributions in the GLIMMIX procedure of SAS with herd included as a random variable. The statistical model for expression of estrus included treatment, age (heifer or cow), and the treatment by age interaction. The statistical model for pregnancy included treatment, estrus, age, and all 2- and 3-way interactions. Differences were considered to be significant when $P \leq 0.05$ and a tendency when $P > 0.05$ but $P \leq 0.10$.

3. Results

3.1. Interval to estrus (INTERVAL 1)

There was an effect of age ($P < 0.0001$) on interval to estrus, heifers had a shorter interval to estrus compared to cows (50 h ± 1.1 h vs 54 ± 1 h, respectively). Furthermore, a weak tendency for an effect of treatment ($P = 0.11$), and a treatment by age interaction ($P = 0.05$; Fig. 1), on interval to estrus were detected. Heifers treated with 5 μg of GnRH at CIDR removal tended to have a shorter interval to estrus ($P = 0.07$; 47 ± 1.4 h) compared to 0 μg (50 ± 1.5 h) and did have a shorter interval compared to 10 μg ($P < 0.01$; 52 ± 1.5 h). However, there were no differences between treatments in interval to estrus among cows ($P \geq 0.34$).

3.2. Interval to GnRH-Induced LH surge (INTERVAL 2)

When animals that did not exhibit estrus were included in the analysis at 120 h (INTERVAL 2), there was an effect of age ($P = 0.03$), and treatment ($P < 0.0001$) on interval. Heifers had a shorter interval compared to cows (70 h vs 73 h, respectively). Furthermore, animals administered 5 μg of GnRH had a shorter ($P = 0.05$) interval compared to the 0 μg treatment (68 ± 1.3 h vs 71 ± 1.3 h, respectively), and both the 5 μg and the 0 μg treated animals had a shorter ($P \leq 0.02$) interval compared to the 10 μg (76 ± 1.3 h) treatment of GnRH. There was no treatment by age interaction ($P = 0.50$) on interval.

3.3. Expression of estrus

Treatment ($P < 0.001$), but not age ($P = 0.96$) or treatment by age ($P = 0.74$) influenced expression of estrus. Administration of 5 μg of GnRH at CIDR removal tended to result in more expression of estrus ($P = 0.10$; 79 ± 4%) compared to 0 μg (74 ± 5%). Administration of 10 μg of GnRH at CIDR removal resulted in less expression of estrus compared to either of the other treatments ($P < 0.04$; 68 ± 6%; Fig. 2).

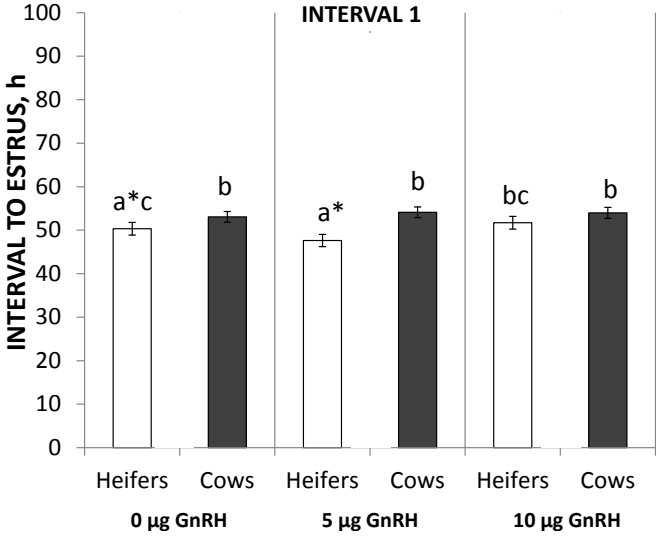

Fig. 1. Treatment by age interaction on interval to estrus (h) following CIDR removal for animals that exhibited estrus prior to 120 h (INTERVAL 1). [abc]Superscripts differ ($P < 0.05$), similar superscripts with asterisks (*) represent tendencies ($P > 0.05$ but $P \leq 0.10$).