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Summary

Three experiments were conducted to evaluate whether pubertal status and number of estrous cycles prior to breeding influences pregnancy rate in beef heifers. Pubertal heifers were heavier and older at the start of breeding and had greater AI and overall pregnancy rate than non-pubertal heifers. Second season pregnancy rate was greater for heifers reaching puberty prior to first breeding and for heifers having ≥ 2 estrous cycles prior to breeding compared with non-pubertal heifers. Pregnancy rate was greater for heifers achieving puberty prior to breeding; however, earlier onset of puberty did not significantly improve first pregnancy rates.

Introduction

Replacement heifer development can significantly impact the profitability of a beef cattle operation. Heifers that conceive early in the breeding season calve earlier and wean heavier calves, increasing longevity and productivity within the herd. Pregnancy rates have been correlated with the percentage of heifers that reach puberty before or early in the breeding season. It has been demonstrated that heifers inseminated on pubertal estrus had a decreased pregnancy rate compared with heifers inseminated on their third estrus. However, heifers inseminated on pubertal estrus were inseminated at an earlier date than heifers inseminated on the third estrus. Therefore, heifers inseminated on the pubertal estrus were younger and weighed less at breeding. Beef heifer reproductive performance has changed over time and is hypothesized to be due to genetic selection with the implementation of Expected Progeny Difference (EPD) for traits such as growth, milk, carcass characteristics, and scrotal circumference. Therefore, the objectives of this study were to determine the effect of pubertal status and the number of estrous cycles prior to breeding on pregnancy rates in beef heifers.

Procedure

All animal procedures and facilities were approved by the University of Nebraska–Lincoln Institutional Animal Care and Use Committee.

Data were collected at the West Central Research and Extension Center (WCREC), North Platte, Neb., from 2002 to 2011 (n = 1,005, Experiment 1) and Gudmundsen Sandhills Laboratory (GSL), Whitman, Neb., from 1997 to 2011 (n = 1,253, Experiment 2; n = 156, Experiment 3). Heifers at WCREC were Angus-based and synchronized with a melengestrol acetate-$PGF_{2\alpha}$ protocol (*2010 Nebraska Beef Cattle Report*, pp. 11-13) prior to AI. Approximately 10 days following AI, heifers were exposed to fertile bulls at a bull to heifer ratio of 1:50 for 60 days. Conception to AI was determined 45 days after AI by transrectal ultrasonography, and final pregnancy rate was determined via transrectal ultrasonography 45 days following removal of bulls.

Data from GSL were collected on a spring calving herd of composite Red Angus × Simmental females. Heifers were exposed to bulls for 45 days at a bull to heifer ratio of 1:25. A single injection of $PGF_{2\alpha}$ was administered i.m. to heifers 108 hours after placement with bulls. Pregnancy determination was performed via transrectal ultrasonography approximately 45 days after the breeding season.

Pubertal status was determined by evaluating progesterone concentration in two blood samples collected via coccygeal venipuncture 10 days apart prior to the breeding season for Experiments 1 and 2. The number of estrous cycles prior to the breeding season in Experiment 3 was determined via serial blood collection every 10 days beginning in early January of each year until the beginning of the breeding season (late May). Progesterone concentration >1 ng/mL was interpreted to indicate ovarian luteal activity. Heifers in Experiment 3 were further classified as non-pubertal or pubertal (0 vs. ≥ 1 estrous cycle) and as having exhibited 1 estrous cycle or greater than or equal to 2 estrous cycles, excluding heifers that had not reached puberty (1 vs. ≥ 2) prior to breeding to evaluate effects on pregnancy rate.

Statistical Analysis

The statistical model included pubertal status or number of estrous cycles prior to breeding as a fixed effect and random effects included year and treatment within year. Data were analyzed using PROC GLIMMIX of SAS (SAS Institute, Inc., Cary, N.C.). Means were separated using least significant difference (LSD). Effects of pubertal status or number of estrous cycles were considered to be significant when P ≤ 0.05, a tendency when P ≤ 0.10, or a trend when P ≤ 0.15.

Results

Experiment 1

Date of birth, BW, pregnancy rate, and first calving characteristics of heifers classified by pubertal status prior to breeding are presented in Table 1. Julian birth date was similar (*P* = 0.12) for heifers that were pubertal or non-pubertal. Pubertal heifers had greater (*P* < 0.01) BW compared with non-pubertal heifers from weaning through final pregnancy diagnosis. Weaning to final pregnancy diagnosis ADG was similar

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for pubertal and non-pubertal heifers ($P = 0.62$; 1.19 vs. 1.17 ± 0.11 lb/day, respectively), providing evidence that differences in post-weaning BW were likely due to greater pre-weaning ADG for heifers that reached puberty prior to breeding. Heifers that were pubertal prior to breeding tended ($P = 0.08$) to have greater AI pregnancy rate (62 vs. 56 ± 4%) and greater ($P < 0.01$) overall pregnancy rate (94 vs. 88 ± 2%) compared with non-pubertal heifers. Days to calving was decreased ($P < 0.01$) for pubertal vs. non-pubertal heifers; however, calf birth BW did not differ ($P = 0.92$; 75 ± 1.5 lb).

Experiment 2

Date of birth, BW, ADG, pregnancy rate, and first calf characteristics of heifers classified by pubertal status prior to breeding are presented in Table 2. Heifers that were pubertal prior to breeding were born approximately four days earlier ($P < 0.01$) than non-pubertal heifers.

Heifer birth BW did not differ ($P = 0.28$) between groups. However, pubertal heifers had greater ($P < 0.01$) weaning and pre-breeding BW, and tended ($P = 0.08$) to be heavier at pregnancy diagnosis than non-pubertal heifers. Heifers that were pubertal prior to breeding had greater ($P < 0.01$) ADG from birth to weaning. Heifers that did not reach puberty prior to breeding tended ($P = 0.09$) to have greater ADG from weaning to pre-breeding and had greater ($P < 0.01$) ADG from breeding to pregnancy diagnosis. The greater ADG from weaning to pregnancy diagnosis by non-pubertal heifers resulted in a similar ($P = 0.41$) BW at pre-calving.

Pregnancy rate was greater ($P < 0.01$) for pubertal heifers vs. non-pubertal heifers (90 vs. 84 ± 2%, respectively). A greater ($P < 0.01$) proportion of pubertal heifers calved within the first 21 days of the calving season compared with heifers classified as non-pubertal prior to breeding. Date of calving was five days earlier for heifers that were pubertal prior to breeding, and their calves were heavier ($P < 0.01$) at birth and were heavier and older ($P < 0.05$) at weaning than calves from heifers that were not pubertal prior to breeding. At weaning, there was no difference ($P > 0.90$) in BW (699 ± 18.5 lb) and BCS (5.1 ± 0.1) between first-calf heifers classified as pubertal or non-pubertal before start of breeding as heifers. Second season pregnancy rate was also similar ($P = 0.65$) between groups.

Table 1. Birth date, BW, pregnancy rate, and first calf characteristics of heifers classified by pubertal status prior to breeding. (Experiment 1)[1]

	Pubertal	Non-Pubertal	SE	*P*-value
N	695	310		
Julian birth date[2], day	78.9	81.9	1.5	0.12
Weaning BW, lb	529	512	9.5	<0.01
AI BW, lb	786	768	26.6	<0.01
AI pregnancy rate, %	61.9	55.5	3.7	0.08
Overall pregnancy diagnosis BW, lb	932	916	18.2	<0.01
Overall pregnancy rate, %	94.2	87.7	1.9	<0.01
Days to calving[3], day	284	288	2.0	<0.01
Calve within first 21 days[4], %	77.8	66.2	5.1	<0.01

[1]Performed at the West Central Research and Extension Center (WCREC), North Platte, Neb.
[2]Birth date was known for only a subset of heifers (n = 360).
[3]Days from start of breeding season to calving.
[4]Calved within the first 21 days of the calving season; day 1 refers to the day the first calf is born.

Table 2. Birth date, BW, ADG, pregnancy rate, and first calf characteristics of heifers classified by pubertal status prior to breeding. (Experiment 2)[1]

	Pubertal	Non-Pubertal	SE	*P*-value
N	752	491		
Julian birth date, day	83.9	87.8	4.8	<0.01
Born first 21 days[2], %	63.8	49.7	5.9	<0.01
Birth BW, lb	77	78	1.4	0.28
Weaning BW, lb	461	445	6.7	<0.01
Birth to weaning ADG, lb	1.74	1.70	0.08	<0.01
Pre-breeding age, day	428	424	2.9	<0.01
Pre-breed BW, lb	665	649	9.6	<0.01
Pre-breed ADG, lb	0.99	1.01	0.07	0.09
Pregnancy diagnosis BW, lb	812	805	9.6	0.08
Breeding to pregnancy diagnosis ADG, lb	1.40	1.49	0.1	<0.01
Pregnancy rate, %	90.0	82.4	2.0	<0.01
Pre-calving BW, lb	933	928	15.7	0.41
Calve within first 21 days[3], %	79.1	67.0	4.3	<0.01
Calf Julian birth date, day	75	80	4.9	<0.01
Calf birth BW, lb	72	70	1.0	<0.01
Calf weaning BW, lb	413	391	12.0	<0.01
Calf weaning age, days	181	177	3.8	0.05
Cow BW at weaning, lb	920	920	18.6	0.99
Cow BCS at weaning	5.1	5.1	0.1	0.91
Second pregnancy rate, %	89.8	91.2	3.1	0.65

[1]Performed at Gudmundsen Sandhills Laboratory (GSL), Whitman, Neb.
[2]Born within the first 21 days of calving season, day 1 is the day the first calf is born.
[3]Calved within the first 21 days of the calving season; day 1 is the day the first calf is born.

Experiment 3

Date of birth, BW, ADG, pregnancy rate, and first calf characteristics are presented in Table 3 for heifers classified by number of estrous cycles prior to the breeding season. Heifers had similar ($P = 0.34$) birth BW regardless of number of estrous cycles prior to breeding. There was a trend ($P = 0.12$) for heifers that had three estrous cycles prior to the breeding season to be born earlier and a tendency ($P = 0.10$) to have greater

Table 3. Birth date, BW, ADG, pregnancy rate, and first calf characteristics of heifers classified by number of estrous cycles prior to breeding. (Experiment 3)[1]

	0	1	2	3	≥4	SE	*P*-value
N	25	16	22	27	66	156	
Julian birth date, day	85.3	85.9	85.8	78.2	84.0	3.1	0.12
Born first 21days[2], %	67.8	80.8	73.1	93.0	78.7	9.3	0.24
Birth BW, lb	79	75	75	80	78	2.9	0.34
Weaning BW, lb	489	494	507	524	504	16.9	0.10
Age at puberty, days	—	409[a]	394[ab]	379[b]	324[c]	6.3	<0.01
Puberty BW, lb	—	697[a]	713[a]	695[a]	573[b]	30.1	<0.01
Wean to puberty ADG, lb/day	—	1.08a	1.09[a]	1.09[a]	0.61[b]	0.1	<0.01
Pre-breed BW, lb	830	844	865	895	848	38.3	0.16
Pregnancy diagnosis BW, lb	797	804	807	837	802	29.1	0.27
Pregnancy rate, %	68.0	81.3	86.4	92.6	81.8	9.4	0.15
Wean to pregnancy diagnosis ADG, lb/day	1.06	1.07	1.05	1.09	1.04	0.09	0.79
Puberty to pregnancy diagnosis ADG, lb	—	1.14[a]	0.83[b]	1.09[ab]	1.26[a]	0.19	<0.01
Pre-calving BW, lb	939	939	972	1004	958	35.4	0.10
Calve within first 21days[3], %	65.3	83.6	87.6	82.7	75.1	14.2	0.47
Calf Julian birth date, day	72.5	66.9	63.4	67.8	68.8	4.5	0.20
Calf birth BW, lb	67.7	67.2	68.8	70.3	69.5	3.1	0.78
Second pregnancy rate, %	79.5[b]	87.2[ab]	100.0[a]	97.0[a]	97.9[a]	8.0	0.03

[a-c]Means without a common superscript differ (P ≤ 0.05).
[1]Performed at Gudmundsen Sandhills Laboratory (GSL), Whitman, Neb.
[2]Born within the first 21 days of calving season, day 1 is the day the first calf is born.
[3]Calved within the first 21 days of the calving season; day 1 is the day the first calf is born.

weaning BW compared with heifers that exhibited estrus ≤ 2 and ≥ 4 times.

Heifers exhibiting ≥ 4 estrous cycles were younger ($P < 0.01$; 409, 394, 379, 324 ± 6.3 days, for 1, 2, 3, and ≥ 4 estrous cycle groups, respectively) and had reduced ($P < 0.01$) BW at puberty than heifers exhibiting estrus ≤ 3 times. Heifers that exhibited ≤ 3 estrous cycles had similar ($P \geq 0.92$) BW at puberty.

There was a trend ($P = 0.15$) for pregnancy rate to increase with the number of estrous cycles exhibited prior to breeding. Heifers that were pubertal prior to breeding had greater ($P = 0.05$; 85 vs. 68 ± 8%) pregnancy rate than non-pubertal heifers. Pregnancy rate did not differ for heifers having one estrous cycle compared with heifers having ≥ 2 estrous cycles prior to breeding ($P = 0.68$; 81 vs. 85 ± 9% for 1 and ≥ 2, respectively). In contrast, Byerley et al. (*Journal of Animal Science*, 1987, 65:645-650) reported pregnancy rate was decreased 21 percentage points for heifers inseminated at pubertal estrus compared with third estrus. In the current study, heifers were placed with bulls or AI on a common date resulting in similar age at breeding, whereas date of insemination in Byerley et al. (*Journal of Animal Science*, 1987, 65:645-650) was earlier for heifers at pubertal estrus compared with heifers inseminated on third estrus, resulting in heifers inseminated on first estrus being approximately 50 days younger at breeding.

Heifers that were pubertal prior to the first breeding season had a greater ($P < 0.01$) second season pregnancy rate than heifers that were non-pubertal prior to the first breeding season (97 vs. 80 ± 7%). Second season pregnancy rate was greater ($P = 0.03$) for heifers having ≥ 2 estrous cycles prior to the first breeding season than heifers having ≤ 1 estrous cycle; however, heifers that had 0 or 1 estrous cycle had similar ($P = 0.81$) second season pregnancy rates (80, 87, 100, 97, and 98 ± 8% for 0, 1, 2, 3, and ≥ 4 estrous cycle groups, respectively). Heifers with ≥ 2 estrous cycles prior to the first breeding season also tended ($P = 0.08$) to have a greater second season pregnancy rate compared with heifers that had 1 estrous cycle (98 vs. 88 ± 6% for ≥ 2 and 1 estrous cycles, respectively). Therefore, it is recommended to develop heifers to reach puberty and allow for at least one estrous cycle prior to the breeding season to optimize heifer pregnancy rates; however, multiple estrous cycles prior to breeding did not significantly improve subsequent pregnancy rates.

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