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Nebraska Beef Cattle Reports

Animal Science Department

2018

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Summary with Implications

Heifer records were retrospectively evaluated to see if Julian birthdate, cycling status prior to breeding, and body weight collected from weaning through final pregnancy diagnosis differed when heifers were categorized by 5 different approaches: 1) pubertal status prior to estrous synchronization, 2) whether or not detected in estrus at AI, 3) heifers impregnated by AI vs all other heifers, 4) final pregnancy status, and 5) a 5-way classification accounting for AI and pregnancy status (AI pregnant, heifers subjected to AI that subsequently conceived to bull, heifers not AI that were impregnated by bull, heifers subjected to AI that were not pregnant, heifers not AI and not pregnant). Collectively, results support the concept that earlier birth in the calving season and greater preweaning growth are associated with desirable reproductive response in replacement beef heifers.

Introduction

Numerous studies have reported inverse correlations between postweaning growth rate and age at puberty and pregnancy rates in heifers. Pregnancy rate was greater for heifers achieving puberty prior to breeding, which was influenced by age and BW (2014 Nebraska Beef Report, pp. 5-7). An increasing body of literature (2005 Nebraska Beef Report, pp. 15-17; 2008 Nebraska Beef Report, pp. 8-10; 2012 Nebraska Beef Report, pp. 37-40; 2017 Nebraska Beef Report, pp. 5-7) has also demonstrated postbreeding management can have significant impacts on breeding success. However, limited information exists on which time points prior to or after the breeding season have the greatest impacts on reproductive success.

Therefore the objective of this study was to retrospectively analyze heifer data to evaluate how growth up to and through the breeding season differed when beef heifers were categorized by puberty and pregnancy status.

Procedure

The University of Nebraska-Lincoln Institutional Animal Care and Use Committee approved all procedures and facilities used in this experiment.

Crossbred, Angus-based heifers were purchased and arrived at the West Central Research and Extension Center (WCREC), North Platte, NE, at or shortly after weaning. Various development treatments (2005 Nebraska Beef Report, pp.15-17; 2008 Nebraska Beef Report, pp. 8-10; 2010 Nebraska Beef Report, pp. 10-12; 2012 Nebraska Beef Report, pp. 37-40; 2013 Nebraska Beef Report, pp. 5-10; 2017 Nebraska Beef Report, pp. 5-7) were applied overwinter. Prior to estrus synchronization, 2 blood samples were collected 10 d apart via caudal venipuncture to determine pubertal status. Heifers with greater than 1 ng/mL progesterone at either collection were considered pubertal. Heifers were synchronized using the melengestrol acetate-prostaglandin F2α (MGA-PG) protocol. Heifers received MGA for 14 d. On d 33, PG was injected i.m. Heat detection followed for 5 d after injection. Heifers were observed for standing estrus and AI 12 h later. Heifers not expressing estrus were not inseminated. Ten days after last AI, clean-up bulls were added at a 1:50 bull to heifer ratio for a 60 d breeding season. Pregnancy diagnosis was conducted via transrectal ultrasonography 45 d following AI and again 45 d after bull removal.

Records from heifers born in 2002 to 2015 (n=1,404) were analyzed. Birthdate was available for a subset of heifers (n=749) and included in the analysis. Pubertal status prior to estrus synchronization was available for all but 2 yr. Six BW measures were recorded for most heifers: weaning, mid-winter, pre-synchronization, AI, first pregnancy diagnosis, and final pregnancy diagnosis. Weaning BW was either a single measure or an average of 2 measures taken within 2 to 3 wk after arriving at WCREC and occurred from mid-October to early November. Mid-winter BW was measured between mid-January to mid-February. Pre-synchronization was averaged from 2 BW taken 10 d apart immediately prior to MGA supplementation and occurred in mid-April. Body weight recorded at AI was measured at PG injection in late May. First pregnancy diagnosis BW occurred in mid-July, approximately 45 d after the last AI date. Final pregnancy diagnosis BW was measured in late September, approximately 45 d after bull removal. From the BW measures, 8 ADG measures were calculated for the database: weaning to mid-winter, mid-winter to pre-synchronization, pre-synchronization to AI, AI to first pregnancy diagnosis, first pregnancy diagnosis to final pregnancy diagnosis, weaning to pre-synchronization, weaning to AI, and AI to final pregnancy diagnosis.

Heifers were categorized by 5 different approaches: 1) pubertal status prior to estrus synchronization, 2) whether or not detected in estrus and inseminated, 3) heifers impregnated by AI vs all other heifers, 4) final pregnancy status (yes vs no), and 5) a 5-way classification accounting for AI and pregnancy status. The 5-way classification included heifers conceiving to AI (AIpreg, n=816), heifers subjected to AI that subsequently conceived to bull (AIbull, n=351), heifers not inseminated that were impregnated by bull (notAIpreg, n=150), heifers inseminated that were not pregnant (AIopen, n=93), heifers not inseminated and not pregnant (notAIopen, n=28).

The GLIMMIX procedure of SAS was used to retrospectively evaluate if Julian birthdate, cycling status prior to breeding, and BW measures collected from weaning through final pregnancy diagnosis varied among the categories in the different approaches. The model included birth yr as a random effect and fixed effect of pubertal status/breeding/pregnancy category.

Results

Pubertal Status Prior to Estrus Synchronization

Pubertal heifers prior to estrus synchronization were born 3 d earlier ($P = 0.04$; 83 vs 80 Julian birthdate, non-pubertal vs pubertal, respectively; Table 1). Pubertal heifers were heavier ($P < 0.01$) at all BW measured. In addition, pubertal heifers gained more ($P < 0.01$) BW from weaning to mid-winter, mid-winter to pre-synchronization, and consequently weaning to pre-synchronization. While pubertal heifers also exhibited greater ($P < 0.01$) ADG from weaning to AI, non-pubertal heifers tended to gain more ($P = 0.06$) from pre-synchronization to AI (1.68 vs 1.59 lb/d, non-pubertal vs pubertal, respectively).

Heifers not cycling prior to estrus synchronization did gain more ($P < 0.01$) from AI to first pregnancy diagnosis and AI to final pregnancy diagnosis. This pattern of gain, where non-pubertal heifers have increased ADG during the breeding season indicates these heifers were possibly later maturing, with greater mature BW or exhibiting a compensatory gain due to better quality forage available during synchronization and breeding periods.

Estrus Detection and Artificial Insemination

Heifers observed in estrus and inseminated tended to be born earlier, and thus were older than heifers not observed in estrus ($P = 0.08$, 81 vs 85 Julian birthdate for inseminated vs non-inseminated, respectively; Table 2). Inseminated heifers were heavier ($P \leq 0.04$) at weaning and all subsequent BW compared with heifers not inseminated.

Gains were similar between categories, except from first to final pregnancy diagnosis where inseminated heifers had greater ADG ($P < 0.01$, 1.50 vs 1.61 lb/d, non-inseminated vs inseminated, respectively).

AI Pregnancy vs All Others

Heifers pregnant by AI were born 3 d earlier ($P = 0.02$, 80 vs 83 Julian birthdate,

Table 1. Comparison of BW and ADG between cyclic vs non-cyclic heifers prior to estrus synchronization. Heifers were synchronized with a melengestrol acetate (MGA)-PG protocol

	Non-cyclic	Cyclic	SE	*P*-value
Julian birthdate	83	80	1.5	0.04
BW, lb				
Weaning[1]	509	527	3.5	< 0.01
Mid-winter[2]	600	624	4.6	< 0.01
Pre-synchronization[3]	697	745	5.3	< 0.01
AI[4]	758	807	5.3	< 0.01
First pregnancy diagnosis[5]	807	838	5.1	< 0.01
Final pregnancy diagnosis[6]	924	955	5.3	< 0.01
ADG, lb/d				
Weaning to mid-winter	0.99	1.10	0.02	< 0.01
Mid-winter to pre-synchronization	1.46	1.59	0.04	< 0.01
Pre-synchronization to AI	1.68	1.59	0.04	0.06
AI to first pregnancy diagnosis	1.01	0.79	0.04	< 0.01
First to final pregnancy diagnosis	1.65	1.59	0.02	0.08
Weaning to pre-synchronization	1.08	1.28	0.02	< 0.01
Weaning to AI	1.19	1.32	0.02	< 0.01
AI to final pregnancy diagnosis	1.15	1.04	0.02	< 0.01

[1]Mid-October to early November.
[2]Mid-January to mid-February.
[3]Average of 2 BW measured 10 d apart immediately prior to MGA supplementation.
[4]Late May, measured at PG injection.
[5]Mid-July, approximately 45 d after last AI d.
[6]Late September, approximately 45 d after bull removal from 60-d breeding season.

Table 2. Comparison of BW and ADG between AI and non-AI heifers. Heifers were synchronized with a melengestrol acetate (MGA)-PG protocol and only heifers displaying estrus behavior were inseminated

	Not AI	AI	SE	*P*-value
Julian birthdate	85	81	2.0	0.08
BW, lb				
Weaning[1]	509	518	4.2	0.04
Mid-winter[2]	602	615	5.3	0.03
Pre-synchronization[3]	710	725	6.4	0.02
AI[4]	769	785	6.6	0.01
First pregnancy diagnosis[5]	816	829	5.7	0.03
Final pregnancy diagnosis[6]	926	946	6.2	< 0.01
ADG, lb/d				
Weaning to mid-winter	1.04	1.06	0.02	0.37
Mid-winter to pre-synchronization	1.50	1.54	0.04	0.44
Pre-synchronization to AI	1.54	1.61	0.04	0.17
AI to first pregnancy diagnosis	1.04	0.99	0.04	0.25
First to final pregnancy diagnosis	1.50	1.61	0.04	< 0.01
Weaning to pre-synchronization	1.19	1.21	0.02	0.24
Weaning to AI	1.23	1.28	0.02	0.11
AI to final pregnancy diagnosis	1.12	1.15	0.02	0.19

[1]Mid-October to early November.
[2]Mid-January to mid-February.
[3]Average of 2 BW measured 10 d apart immediately prior to MGA supplementation.
[4]Late May, measured at PG injection.
[5]Mid-July, approximately 45 d after last AI d.
[6]Late September, approximately 45 d after bull removal from 60-d breeding season.

Table 3. Comparison of BW and ADG between heifers pregnant by AI vs heifers pregnant by natural service or open

	Not AI pregnant	AI pregnant	SE	*P*-value
Julian birthdate	83	80	1.4	0.02
BW, lb				
Weaning[1]	513	518	2.9	0.10
Mid-winter[2]	608	615	3.7	0.16
Pre-synchronization[3]	721	725	4.4	0.36
AI[4]	780	785	4.4	0.37
First pregnancy diagnosis[5]	825	829	4.0	0.23
Final pregnancy diagnosis[6]	935	950	4.2	< 0.01
ADG, lb/d				
Weaning to mid-winter	1.06	1.06	0.02	0.75
Mid-winter to pre-synchronization	1.57	1.50	0.02	0.04
Pre-synchronization to AI	1.61	1.61	0.02	0.83
AI to first pregnancy diagnosis	0.97	1.01	0.04	0.39
First to final pregnancy diagnosis	1.50	1.65	0.02	< 0.01
Weaning to pre-synchronization	1.21	1.21	0.02	0.85
Weaning to AI	1.28	1.28	0.02	0.87
AI to final pregnancy diagnosis	1.08	1.17	0.02	< 0.01

[1]Mid-October to early November.
[2]Mid-January to mid-February.
[3]Average of 2 BW measured 10 d apart immediately prior to MGA supplementation.
[4]Late May, measured at PG injection.
[5]Mid-July, approximately 45 d after last AI d.
[6]Late September, approximately 45 d after bull removal from 60-d breeding season.

Table 4. Comparison of BW and ADG between nonpregnant vs pregnant (includes AI and natural service) heifers

	Not Pregnant	Pregnant	SE	*P*-value
Julian birthdate	85	81	2.3	0.15
BW, lb				
Weaning[1]	500	518	4.9	< 0.01
Mid-winter[2]	597	613	6.6	0.01
Pre-synchronization[3]	701	725	7.5	< 0.01
AI[4]	763	785	7.5	0.01
First pregnancy diagnosis[5]	805	829	7.1	< 0.01
Final pregnancy diagnosis[6]	911	946	7.1	< 0.01
ADG, lb/d				
Weaning to mid-winter	1.06	1.06	0.04	0.74
Mid-winter to pre-synchronization	1.43	1.54	0.04	0.06
Pre-synchronization to AI	1.63	1.61	0.07	0.69
AI to first pregnancy diagnosis	0.90	0.99	0.07	0.11
First to final pregnancy diagnosis	1.48	1.61	0.04	< 0.01
Weaning to pre-synchronization	1.17	1.21	0.02	0.19
Weaning to AI	1.26	1.28	0.02	0.25
AI to final pregnancy diagnosis	1.06	1.15	0.02	< 0.01

[1]Mid-October to early November.
[2]Mid-January to mid-February.
[3]Average of 2 BW measured 10 d apart immediately prior to MGA supplementation.
[4]Late May, measured at PG injection.
[5]Mid-July, approximately 45 d after last AI d.
[6]Late September, approximately 45 d after bull removal from 60-d breeding season.

AI pregnant vs not AI pregnant, respectively; Table 3) than their counterparts. Body weight was similar between the two categories until final pregnancy diagnosis, where heifers not pregnant by AI weighed less ($P < 0.01$, 935 vs 950 lb, not AI pregnant vs AI pregnant, respectively). This may be due to the difference in weight of the pregnancy.

Heifers not pregnant by AI did gain more from mid-winter to pre-synchronization ($P = 0.04$, 1.57 vs 1.50 lb/d, not pregnant by AI vs pregnant by AI, respectively); however, they gained less ($P < 0.01$) BW from first to final pregnancy diagnosis and AI to final pregnancy diagnosis. Again the greater gains for AI pregnant heifer may be due to the weight of the actual pregnancy.

Final Pregnancy Status

Although age was similar between nonpregnant and pregnant heifers ($P = 0.15$, Table 4), BW was greater ($P < 0.01$) for pregnant heifers (AI and bull-bred) at all measures.

Nonpregnant heifers tended ($P = 0.06$) to gain less from mid-winter to pre-synchronization (1.43 vs 1.54 lb/d, nonpregnant vs pregnant, respectively). Nonpregnant heifers also gained less ($P < 0.01$) from first to final pregnancy diagnosis and AI to final pregnancy diagnosis.

5-way Classification of AI and Pregnancy Status

Julian date of birth did not differ due to AI and pregnancy classification, although the numeric trend was for AIpreg to be born earlier. The percentage of heifers cycling prior to estrus synchronization differed among the groupings, following the pattern of being greatest in AIpreg (76%), intermediate in AIopen (62%), and least in notAIopen (24%). Percentage cycling in heifers bred by bulls (70% for both AIbull and notAIpreg) was similar to AIpreg and AIopen (76% and 62%, AIpreg and AIopen, respectively). Measures of weaning BW differed due to classification, and these differences persisted through the remaining measurements (Figure 1). The general pattern was for heifers in the AIpreg and AIbull groups to be heavier than AIopen, which tended or were heavier than notAIopen. Heifers in

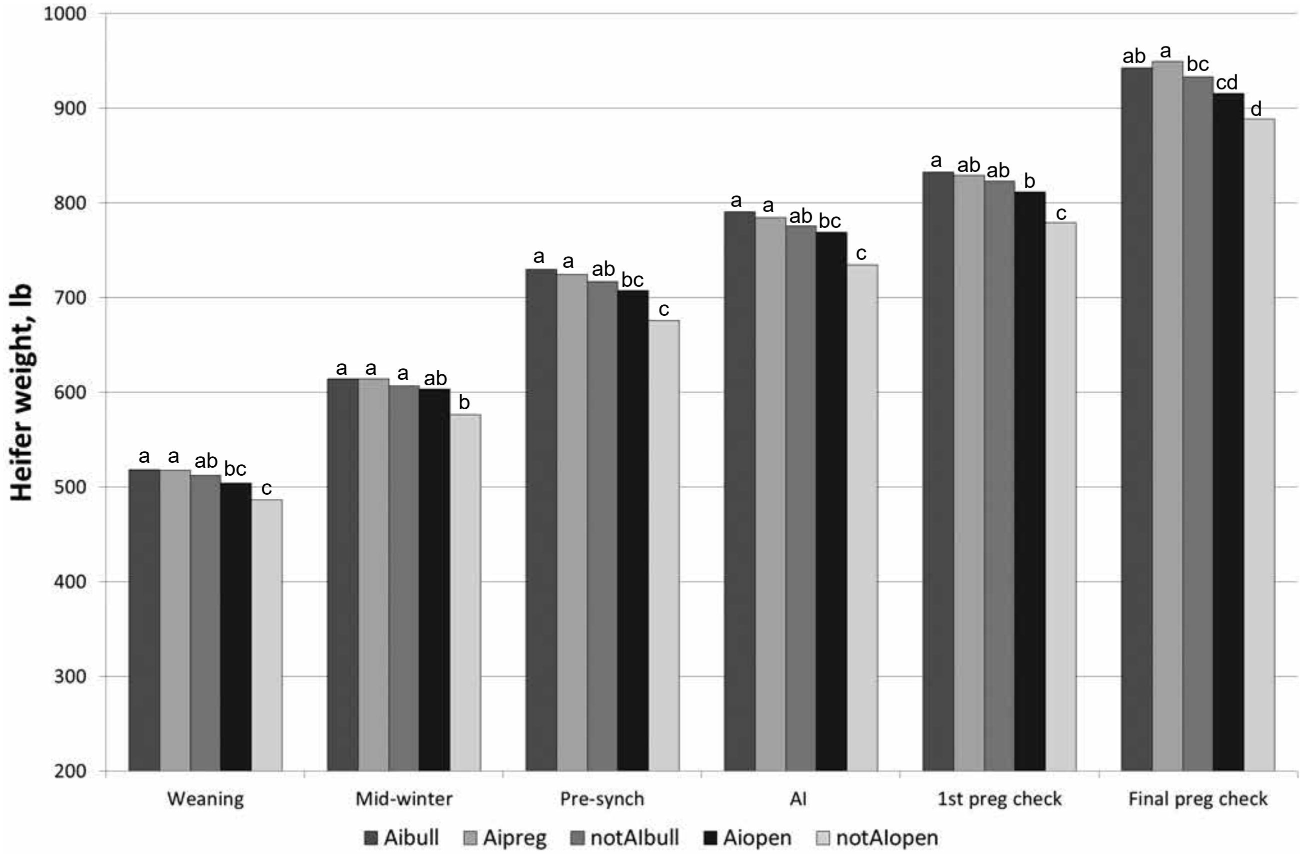

Figure 1. Retrospective comparison of BW at 6 different time points among heifers inseminated but became pregnant by natural service (AIbull), heifers pregnant by AI (AIpreg), heifers not inseminated but became pregnant by natural service (notAIpreg), inseminated heifers not becoming pregnant (AIopen), and heifers not inseminated and not becoming pregnant (notAIopen). Bars with different letters differ ($P < 0.05$). AIopen tended ($P < 0.1$) to differ from notAIopen.

the nonAIpreg group were intermediate, but not statistically different between the AIpreg, AIbull, and AIopen.

Birthdate and weaning BW seem to be the 2 major factors accounting for whether heifers became pregnant or not, as the differences in BW between pregnant and not pregnant heifers remained similar through the breeding season. A greater percentage of heifers becoming pregnant were also cyclical prior to estrus synchronization compared with nonpregnant heifers.

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