Effect of growing beef replacement heifers on wheat pasture before and during breeding on reproductive performance

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ABSTRACT
Reproductive performance of heifers grazing wheat pasture before and during breeding was compared with heifers grazing wheat pasture until approximately 3 wk before breeding. In each of 2 yr, 40 Angus and crossbred heifers were placed on wheat pasture in December and assigned to treatment groups in mid March. Group 1 (WP; n = 20) remained on wheat pasture through estrus synchronization and fixed-time AI (FAI). Group 2 (DL; n = 20) was placed in drylot and fed a corn-based growing ration (11.1% CP) through estrus synchronization and FAI. Heifers were exposed to bulls 10 d after FAI for 45 d. Conception rate to FAI (53 vs. 43%) and final pregnancy rate (95 vs. 88%) were similar for WP and DL. Concentrations of urea were less (5.77 vs. 29.15 mg/dL) for DL heifers during all weeks after treatments were imposed. Reproductive performance of heifers grazing wheat pasture during estrus synchronization and FAI was similar to that of drylot heifers consuming a corn-based growing diet.

Key words: replacement heifer, reproduction, wheat pasture

INTRODUCTION
Growing beef cattle on wheat pasture is a major beef production program in the southern Great Plains. Wheat pasture provides an excellent alternative for the development of replacement heifers. Some producers have adopted the method of growing beef replacement heifers on wheat pastures as a way to diversify their operations. Unsatisfactory breeding performance has been suggested by producers when replacement heifers have been exposed to bulls or AI while grazing small grains.

Wheat pasture contains a high amount of CP. Soluble nitrogen makes up a significant amount of the total nitrogen that is found in wheat forage. This soluble nitrogen fraction is highly degraded in the rumen into ammonia. Vogel et al. (1989) reported that 50 to 75% of total wheat forage nitrogen had a very rapid ruminal degradation rate of 16 to 19% per hour.

Reduced pregnancy rates have been reported for heifers grazing wheat and ryegrass pastures when compared with heifers that were program fed to gain 0.68 kg/d with a 13.7% CP diet (Beck et al., 2005). Similarly, extensive research has been done in the dairy industry suggesting that greater percentages of protein in the diet through supplementation of urea or soybean meal are associated with a reduction in fertility (Canfield et al., 1990; Elrod and Butler, 1993; Ferguson et al., 1993).

The reduction in reproductive performance in previous studies has been attributed to high concentrations of urea nitrogen in the blood.
Elrod and Butler (1993) reported that concentrations of plasma urea nitrogen greater than 16 mg/dL in heifers fed diets high in degradable protein decreased pregnancy rates by 30% when compared with heifers with concentrations that were less than 16 mg/dL. Horn et al. (1977) reported that plasma urea nitrogen concentrations of steers grazing wheat pasture ranged from 18.1 to 28.3 mg/dL. These concentrations are greater than the range of plasma urea nitrogen concentrations reported by Elrod and Butler (1993) that resulted in decreased pregnancy rates.

The current study was undertaken with the objective of comparing reproductive performance of heifers that grazed wheat pasture before and during breeding with that of heifers that grazed wheat pasture but were removed approximately 3 wk before breeding.

**MATERIALS AND METHODS**

**Research Site**

A 2-yr trial was conducted during the late fall to early spring of 2006 to 2007 and 2007 to 2008 at the Oklahoma State University (OSU) Wheat Pasture Unit near Stillwater, Oklahoma. The OSU Animal Care and Use Committee approved all experimental procedures used in this study.

**Year 1**

**Pasture and Animal Management.** On September 14, 2006, 36.58 ha of clean tilled wheat pasture was planted to hard red winter wheat (*Triticum aestivum*, variety Endurance) at a seeding rate of 135 kg/ha (2 bu/acre). A preplant application of 115 kg/ha (102 lb/acre) urea (46-0-0) was applied before planting. The wheat pasture was divided into 4 paddocks (average 9.15 ha/paddock). Forty fall-weaned Angus and Angus crossbred heifers were moved to the Wheat Pasture Research Unit on December 13, 2006. Heifers originally came from the OSU Range Cow Research Center, North Range Unit (n = 20) and South Range Unit (n = 20). Cattle grazing wheat pasture were rotated between pastures at approximately 3-wk intervals to allow for adequate forage availability. Heifers had free-choice access to a monensin-containing mineral mixture (R1620) while grazing wheat pasture. The source of the mineral was Vigor (Lamb et al. 2001). Heifers received an intramuscular injection of 100 μg gonadotropin-releasing hormone (Cystorelin, Merial, Athens, GA), and a CIDR (Pfizer Animal Health, New York, NY) was placed intravaginally. Seven days later all heifers received 25 mg prostaglandin F2α (Lutalyse, Pfizer Animal Health) and the CIDR were removed. A second injection of 100 μg gonadotropin-releasing hormone was given 2 d later followed by fixed-time AI using 2 sires equally between treatment groups.

One fertile bull was placed with each group of heifers on April 15. Bulls were rotated between groups on April 23. On May 1, heifers and bulls remaining on wheat pasture and those in drylot were moved to a native range pasture located at the North Range Unit. Heifers were comingled on this native range pasture until the end of the trial. On May 7, all heifers were diagnosed for pregnancy using transrectal ultrasonography. On June 7, bulls were removed and heifers were moved back to their respective herd of origin. Final pregnancy status of the heifers was determined via rectal palpation on September 25.

**Blood Sampling Procedures and Laboratory Analyses.** Blood (10 mL) was sampled by tail venipuncture into Vacutainer tubes (Becton Dickinson Vacutainer Systems, Franklin, NJ) at 0.5, 1, 2, and 3 yr of age. Blood was allowed to clot for 1 h at 4°C and then centrifuged at 1,600 g for 10 min at 4°C. Serum was removed and stored at −20°C. Serum urea nitrogen concentrations were determined using a commercial kit (Becton Dickinson) as described by Lamb et al. (2001). Plasma concentrations of urea nitrogen greater than 16 mg/dL decreased pregnancy rates.

**Table 1. Ingredient and calculated nutrient composition (DM basis) of ration fed to heifers in drylot**

<table>
<thead>
<tr>
<th>Ingredient composition, %</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE L, Mcal/kg</td>
<td>1.61</td>
</tr>
<tr>
<td>NE L, Mcal/kg</td>
<td>0.91</td>
</tr>
<tr>
<td>TN, %</td>
<td>70.24</td>
</tr>
<tr>
<td>Fat, %</td>
<td>2.69</td>
</tr>
<tr>
<td>CP, %</td>
<td>11.11</td>
</tr>
<tr>
<td>Potassium, %</td>
<td>1.18</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>0.59</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.23</td>
</tr>
<tr>
<td>Magnesium, %</td>
<td>0.21</td>
</tr>
<tr>
<td>Sulfur, %</td>
<td>0.19</td>
</tr>
<tr>
<td>Cobalt, mg/kg</td>
<td>0.12</td>
</tr>
<tr>
<td>Copper, mg/kg</td>
<td>10.40</td>
</tr>
<tr>
<td>Iron, mg/kg</td>
<td>90.30</td>
</tr>
<tr>
<td>Manganese, mg/kg</td>
<td>45.00</td>
</tr>
<tr>
<td>Selenium, mg/kg</td>
<td>0.23</td>
</tr>
<tr>
<td>Zinc, mg/kg</td>
<td>20.80</td>
</tr>
</tbody>
</table>

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Lakes, NJ) containing EDTA, stored on ice, and centrifuged at 2,500 \( \times g \) for 20 min at 4°C. Plasma was recovered and stored at \(-20°C\) until analysis. Samples were obtained once a week for 5 wk starting on March 13 and ending on April 10. Samples were blocked for laboratory analysis by treatment, heifer, and day. Concentrations of plasma urea nitrogen were quantified in all blood samples using a commercially available kit (Urea Nitrogen Reagent, Teco Diagnostic, Anaheim, CA). Microplates (Beckman Coulter, Fullerton, CA) were used in the analyses of blood urea nitrogen, and absorbance was measured at 630 nm using a plate reader (Multi-skran Spectrum, Thermo Scientific, Waltham, MA). Intra- and interassay coefficients of variation were 5.0 and 7.5%, respectively.

Concentrations of IGF-I in plasma were determined after acid ethanol extraction (16 h at 4°C) by RIA in all samples (Echternkamp et al., 1990). Intra- and interassay coefficients of variation were 10.8 and 18.3%, respectively.

Concentrations of progesterone in plasma were quantified as described by Vizcarra et al. (1997) using a solid-phase RIA (Coat-A-Count Progesterone kit, Diagnostic Products Corp., Los Angeles, CA). Concentrations of progesterone in plasma samples taken the first 3 wk were used to determine the onset of ovarian luteal activity. Duplicates with a coefficient of variation greater than 10% were reanalyzed. Intra- and interassay coefficients of variation were 3.1 and 9.3%, respectively. The criterion for luteal activity was one or more blood samples with concentrations of progesterone greater than 1 ng/mL (Wettemann et al., 1972).

**Year 2**

**Pasture and Animal Management.** Wheat pastures were planted as described for yr 1 except the planting date was September 19, 2007. The wheat pasture was divided into 4 pastures (average 9.15 ha/pasture). Forty fall-weaned Angus and Angus cross-bred heifers were moved to the wheat pasture research unit on December 7, 2007. Heifers originally came from the OSU Range Cow Research Center, North Range Unit (\( n = 20 \)) and South Range Unit (\( n = 20 \)). Cattle grazing wheat pasture were rotated between pastures at approximately 3-wk intervals to allow for adequate forage availability. Heifers had free-choice access to the same monensin-containing mineral mixture as described for yr 1, while grazing wheat pasture. Mean ± SD daily intake of the mineral mixture and monensin was 0.031 ± 0.004 kg/heifer and 54 ± 6 mg/heifer, respectively. On March 11, 2008, heifers were blocked by location of origin and allotted by weight to 2 treatment groups. The treatment groups and drylot diet (including free-choice access to the mineral mix) were the same as described for yr 1.

One heifer was inadvertently exposed to a bull and was removed from the study. Estrous cycles of the heifers were synchronized starting on March 25 using the same method as in yr 1. Fixed-time AI was performed on April 3.

One fertile bull was placed with each group of heifers on April 15. Bulls were rotated between the groups on April 22. On May 2, heifers and bulls remaining on wheat pasture and those in drylot were moved to a native range pasture located at the North Range Unit. Heifers were conmingled on this native range pasture until the end of the trial. On May 5, all heifers were diagnosed for pregnancy using transrectal ultrasonography. On June 5, bulls were removed and heifers were moved back to their respective herd of origin. Final pregnancy status of heifers was determined via rectal palpation on September 22 (heifers returned to North Range) and September 24 (heifers returned to South Range).

**Blood Sampling Procedures and Laboratory Analyses.** Blood (10 mL) was sampled by tail venipuncture into 10-mL Vacutainer tubes without anticoagulant for serum harvest. Samples were refrigerated overnight at 4°C and then centrifuged at 2,500 \( \times g \) for 20 min at 4°C. Serum was recovered and stored at \(-20°C\) until analysis. Samples were obtained once a week for 5 wk starting on March 11 and ending on April 8. Serum concentrations of progesterone, urea nitrogen, and IGF-I were determined using laboratory procedures described in yr 1.

**Weighing Conditions**

In both years, heifers were gathered at approximately 0800 h on weigh days and held in drylot without feed and water until weights were obtained at 1300 to 1400 h. On the day of timed AI, the heifers were directly removed from wheat pasture or self-feeder to the working facility for AI. No preweight shrink was imposed on the day of AI to avoid additional stress on heifers at the time of insemination. The final weight at the time of the ultrasound was obtained after all heifers were on a common pasture for 6 d.

**Statistical Analyses**

All heifers were equally allocated by source. Body weight and ADG of the heifers were analyzed as a completely random design using the PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). The model included treatment as a fixed effect and year as a random effect.

Concentrations of urea nitrogen and IGF-I were analyzed as repeated measures in a completely randomized design using the PROC MIXED procedure of SAS. Six covariance structures (variance component, compound symmetry, Huynh-Feldt, first-order autoregressive, Toeplitz, and unstructured) were examined to select the best according to the goodness-of-fit statistic. The covariance structure with the best goodness-of-fit statistic was the first-order autoregressive. The statistical model included treatment, day, block, and all interactions. Block was considered to be random, and all other effects in the model were considered fixed. Means were separated...
using significant differences of least square means.

The percentage of heifers with luteal activity, percentage of heifers detected as pregnant by ultrasound, and the final percentage of heifers determined pregnant by rectal palpation were analyzed using the PROC GLIMMIX procedure of SAS with treatment as a fixed effect and year as a random variable.

RESULTS AND DISCUSSION

Forage Production

Mean initial wheat forage mass was 2,354 and 2,115 kg DM/ha for yr 1 and 2, respectively, and adequate wheat forage was available for optimal (greater than 1 kg/heifer per day) heifer growth. No additional hay or supplemental feed was necessary during either winter. Only the mineral supplement described previously was fed to the heifers while they were grazing the wheat pasture.

Heifer Data

Heifer weight and reproductive data are summarized in Table 2. Heifers assigned to drylot or wheat pasture had similar \((P = 0.92)\) BW at the initial placement on wheat pasture. Body weights did not differ \((P = 0.84)\) at the time heifers were allotted to 2 treatment groups. Likewise, final BW measurements were similar \((P = 0.44)\) for heifers in drylot or that grazed on wheat pasture. However, BW at the time of AI differed \((P = 0.01)\) between treatment groups. This difference was likely due to differences in gut fill, because the heifers were not pregnant by rectal palpation.

Figure 1. Blood urea nitrogen concentrations of heifers in drylot (indicated by black line) or grazing wheat pasture (indicated by gray line). Data were pooled across yr 1 and 2 (2006–2007 and 2007–2008). Sample date 1 = treatment allotment date; sample date 3 = initiation of estrus synchronization; sample date 4 = AI date. Trt = treatment.
subjected to the stress of shrinkage on the day of AI. Average daily gain from the initial placement on wheat pasture until heifers were allocated to treatment groups was similar \((P = 0.72)\) between treatments. Average daily gain of heifers in drylot differed \((P = 0.01)\) from heifers grazed on wheat pasture over the time of allotment to treatments to fixed-time AI. Again, some of that difference could be due to differences in gut fill. From the time of AI to the final BW measurement, ADG were different \((P = 0.01)\) between treatments.

Reproductive measures of heifers are summarized in Table 2. There was a tendency \((P = 0.08)\) for a greater percentage of heifers in the wheat pasture group to have luteal activity before estrus synchronization and AI as compared with the drylot group. The percentage of heifers pregnant to fixed-time AI did not differ \((P = 0.38)\). Of drylot heifers, 43% were pregnant to fixed-time AI, and 53% of the wheat pasture heifers were pregnant to fixed-time AI. There was no effect \((P = 0.34)\) of treatment on final pregnancy rate.

**Urea Nitrogen**

At the time the heifers were allotted to the drylot and wheat pasture treatment groups, CP content of wheat forage was 28.4 and 28.3% DM in yr 1 and 2, respectively. At the time of initiation of estrus synchronization, CP content of wheat forage was 26.2 and 27.3% DM in yr 1 and 2, respectively. Urea nitrogen concentrations of heifers in drylot decreased rapidly \((P < 0.01)\) after the heifers were removed from wheat pasture and placed in a drylot. After treatments were imposed (sampling date 1), heifers in drylot had lower \((P < 0.01)\) urea nitrogen concentrations as compared with heifers grazed on wheat pasture (Figure 1). Concentrations of urea nitrogen of heifers in drylot ranged from a high of 24.76 mg/dL to a low of 5.77 mg/dL. Concentrations of urea nitrogen in heifers grazed on wheat pasture ranged from 29.15 to 16.97 mg/dL. Two days before AI (sampling date 4), urea nitrogen concentrations were 22.45 and 7.91 mg/dL for wheat pasture and drylot, respectively.

**Insulin-Like Growth Factor-I**

There was not a treatment-by-day interaction \((P = 0.56)\) for IGF-I concentrations. Mean IGF-I concentrations were similar \((P = 0.36)\) between the drylot group \((198 \text{ ± } 25 \text{ ng/mL})\) and wheat pasture group \((179 \text{ ± } 25 \text{ ng/mL})\). Concentrations of IGF-I of heifers in drylot or grazed on wheat pasture decreased \((P = 0.06)\) from 21 ng/mL \((\text{wk 1})\) to 174 ng/mL \((\text{wk 5})\).

**IMPlications**

Final pregnancy rate of heifers was not affected by grazing wheat pasture during breeding, despite significantly elevated concentrations of blood urea nitrogen. Our results indicate that grazing wheat pasture during breeding does not decrease reproductive performance. Thus, growing heifers on wheat pasture for retained replacements or to sell as bred heifers may be an acceptable way for producers to diversify their operations in the southern Great Plains.

**LITERATURE CITED**


