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

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STORY IN BRIEF

The objective of this study was to compare reproductive performance of heifers grazing wheat pasture before and during breeding with heifers grazing wheat pasture until approximately 3 wk before breeding. In each of 2 yr, 40 spring-born Angus and Angus crossbred heifers were placed on wheat pasture in December and randomly assigned to one of two treatment groups in mid March. Group 1 (Wheat Pasture; n=20) remained on wheat pasture (mean CP 26.6 %) through estrus synchronization and fixed-time AI (FAI). Group 2 (Drylot; n=20) was placed in drylot and had free choice access to a corn-based growing ration (11.1% CP) through estrous synchronization and FAI. Heifers were exposed to fertile bulls 10 d after FAI for 45 d. Conception after FAI was determined at 32 d post-AI by ultrasonography. Five weekly blood samples starting 5 wk before FAI were obtained to describe luteal activity prior to estrous synchronization and for analysis of urea-N concentrations before and during estrous synchronization and FAI. The percentage of heifers with luteal activity was 75% and 55% for Wheat Pasture and Drylot, respectively. Drylot heifers were heavier than Wheat Pasture heifers (408 vs. 394 kg ± 4.49) at the time of AI but were similar when final body weight was measured on native range (417 vs. 414 kg ± 5.26). Conception rate to FAI was similar for Wheat Pasture (53%) and Drylot (43%) and final pregnancy rate was similar for Wheat Pasture (95%) and Drylot (88%). Concentrations of urea were less (5.77 mg/dL vs. 29.15 mg/dL,) for Drylot heifers during all weeks after treatments were imposed. Reproductive performance of heifers grazing wheat pasture during estrous synchronization and FAI was similar to heifers consuming a corn-based growing diet in drylot.

Key Words: replacement heifers, wheat pasture, reproduction

INTRODUCTION

Growing beef cattle on wheat pasture is a major beef production program in the southern Great Plains. The majority of these cattle are stocker cattle that are placed on wheat pasture and grown to heavier weights before being placed in feedlots. However, wheat pasture also provides an excellent alternative to develop replacement heifers. Some producers have adopted the method of growing beef replacement heifers on their 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 artificial insemination (AI) while grazing small grains.

Wheat pasture contains a high amount of crude protein. 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.

It is common for producers to expose yearling replacement heifers to bulls or to AI 2 to 3 wk prior to the start of the breeding season for mature cows. These producers that AI yearling heifers while they are still grazing wheat pasture have reported that although they have a high percentage of heifers displaying estrus, subsequent pregnancy rates are less than their expectations.

Reduced pregnancy rates have been reported for heifers grazing wheat and ryegrass pastures when compared with heifers that were program-fed to gain 0.68kg/d with a
3.7% 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, is 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 mg/dL to 28.3 mg/dL. These concentrations are greater than the range of plasma urea nitrogen concentrations reported by Elrod and Butler that resulted in decreased pregnancy rates (1993).

Several mechanisms have been studied relative to the negative effects of excess dietary protein. One of the mechanisms is the adverse effects that increased dietary protein has on the uterine environment. This change in the uterine environment may be attributed to increased amounts of urea causing a decrease in the pH, decrease in the mineral content and impairing the inflammatory response. Elrod and Butler (1993) concluded that excessive dietary protein causes a decrease in uterine pH during the luteal phase which resulted in the reduction of fertility. The change in uterine environment may in turn affect the viability of sperm and embryos.

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

MATERIALS AND METHODS

Research Site

A two-year trial was conducted during the late-fall to early-spring of 2006 to 2007 and 2007 to 2008 at the Oklahoma State University Wheat Pasture Unit near Stillwater, OK. The Oklahoma State University 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 were 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 prior to planting. The wheat pasture was divided into four paddocks (average 9.15 ha/pasture). 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. Mean ± std dev.daily intake of the mineral mixture and monensin was.045 ±.015 kg/heifer and 82 ± 28 mg/heifer, respectively.

On March 13, 2007 heifers were blocked by location of origin and allotted by weight to two treatment groups. Twenty heifers remained at the research unit and continued to graze wheat pasture. The additional 20 heifers were transported to the OSU Range Cow Research Center, South Unit, where they were placed in a drylot and fed a total mixed ration in self feeders. The ration included 39.9% rolled corn, 34.9% ground alfalfa hay, 22.2% cottonseed hulls, 2.5% cane molasses and 0.2% salt. The corn- based growing ration was formulated to result in a similar rate of gain as heifers grazing wheat pasture. The composition of the diet is summarized in Table 1.

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

Item	
Ingredient composition	
Rolled Corn, %	39.97
Ground Alfalfa Hay, %	34.97
Cottonseed Hulls, %	22.23
Cane Molasses, %	2.55
Salt, %	0.28
Calculated nutrient composition	
NE_m, Mcal/kg	1.61
NE_g, Mcal/kg	0.91
TDN, %	70.24
Fat, %	2.69
Crude Protein, %	11.11
Potassium, %	1.18
Calcium, %	0.59
Phosphorus, %	0.23
Magnesium, %	0.21
Sulfur, %	0.19
Cobalt, ppm	0.12
Copper, ppm	10.40
Iron, ppm	90.30
Manganese, ppm	45.00

Selenium, ppm	0.23
Zinc, ppm	20.80

Estrous cycles of the heifers were synchronized starting on March 27, using the Co-synch plus CIDR protocol described by Lamb, et al (2001). Heifers received an intramuscular injection of 100 µg of GnRH (Cystorelin, Merial; Athens, GA) and a CIDR (Pfizer Animal Health, New York, NY) was placed intravaginally. Seven days later all heifers received 25 mg of prostaglandin F2 alpha (Lutalyse, Pfizer Animal Health) and the CIDRs were removed. A second injection of 100 µg of GnRH was given 2 d later followed by fixed time artificial insemination using two 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. Using transrectal ultrasonography all heifers were diagnosed for pregnancy on May 7. 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 on September 25.

Blood Sampling Procedures and Laboratory Analyses. Blood was sampled by tail venipuncture into vacutainer tubes (Becton Dickinson Vacutainer Systems, Franklin Lakes, NJ) containing ethylenediaminetetraacetic acid, stored on ice, centrifuged at 2500 x g for 20 minutes at 4º C, and plasma was recovered and stored at -20º C until analyzed. 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 (Multiskan Spectrum; Thermo Scientific, Waltham, MA). Intra- and inter-assay coefficients of variation were 5 and 7.5%, respectively.

Concentrations of insulin-like growth factor-I (IGF-I) in plasma were determined after acid ethanol extraction (16h at 4º C) by radioimmunoassay (Echternkamp et al., 1990) in all samples. Intra- and inter-assay 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 radioimmunoassay (Coat-A-Count Progesterone kit. Diagnostic Products Corp). 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 inter-assay 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 pasture was planted as described for yr 1 except planting date was September 19, 2007. The wheat pasture was divided into four pastures (average 9.15 ha/pasture). Forty fall weaned Angus and Angus crossbred 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 a monensin-containing mineral mixture (R1600) while grazing wheat pasture. Mean ± std dev.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 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 year 1. Fixed time artificial insemination 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 comingled on this native range pasture until the end of the trial. Using transrectal ultrasonography all heifers were diagnosed for pregnancy on May 5. On June 5, bulls were removed and heifers were moved back to their respective herd of origin. Final pregnancy status of heifers was determined on September 22 and September 24.

Blood Sampling Procedures and Laboratory Analyses. Blood was sampled by tail venipuncture into 10 mL vacutainer tubes without anticoagulant for serum harvest. Samples were refrigerated overnight at 4º C, centrifuged at 2500 x g for 20 min at 4º C, and serum was recovered and stored at -20º C until analyzed. Samples were obtained once a week for 5 weeks 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 on weigh days and held in drylot without feed and water until weights were obtained at 1300 to 1400. On the day of timed AI, the heifers were directly removed from wheat pasture or self-feeder to the working facility for artificial insemination. No pre-weight 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 ultrasound was obtained after all heifers were on a common pasture for 6 days.

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 variable.

Concentrations of urea nitrogen and IGF-I were analyzed as a completely randomized design using the PROC MIXED procedure of SAS. Six covariance structures (variance component, compound symmetry, Huynh-Feldt, first-order autoregressive, Toepliz 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. Adequate wheat pasture forage was available both years for optimal heifer growth. No additional hay or supplemental feed was necessary during either winter. Only the mineral supplement previously described was fed to the heifers while grazing the wheat pasture.

Heifer Data. Heifer weight and reproductive data are summarized in Table 2. Heifers assigned in drylot or wheat pasture had similar ($P = 0.92$) body weights at the initial placement on wheat pasture. Body weights did not differ ($P = 0.84$) at the time heifers were allotted to two treatment groups. Likewise, final body weight measurements were similar ($P = 0.44$) for heifers in drylot or grazed on wheat pasture. However, body weight at the time of AI differed ($P = 0.01$) between treatment groups. 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. From the time of AI to the final body weight measurement, average daily gains 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 estrous synchronization and AI as compared with the drylot group. The percentage of heifers pregnant to fixed time AI did not differ ($P = 0.38$). Forty three percent of drylot heifers 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.

Table 2. Least square means for body weight and reproductive measures of heifers in Drylot or grazing Wheat Pasture (data pooled across years)

	Treatment			
Item	Drylot	Wheat Pasture	SE	*P* - value
Body wt, kg				
Initial placement on wheat	259.2	259.6	2.96	0.92
Allotment to treatments	358.9	358.0	9.67	0.84
Time of AI	408.0	393.9	4.48	0.01
Final BW on native range	417.0	413.3	5.26	0.44
ADG, kg				

Initial placement-Allotment, 90 days	1.08	1.06	0.082	0.72
Allotment-AI, 23 d	2.13	1.56	0.579	0.01
AI-Final BW, 29 d	0.29	0.63	0.048	0.01
Reproductive measures				
Luteal activity, %	55	75	11	0.08
Pregnant at ultrasound, %	43	53	8	0.38
Final pregnancy status, %	88	95	5	0.34

Urea-nitrogen. 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 lesser ($P < 0.01$) 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 prior to artificial insemination (sampling date 4) urea nitrogen concentrations were 22.45 mg/dL and 7.91 mg/dL for wheat pasture and drylot, respectively.

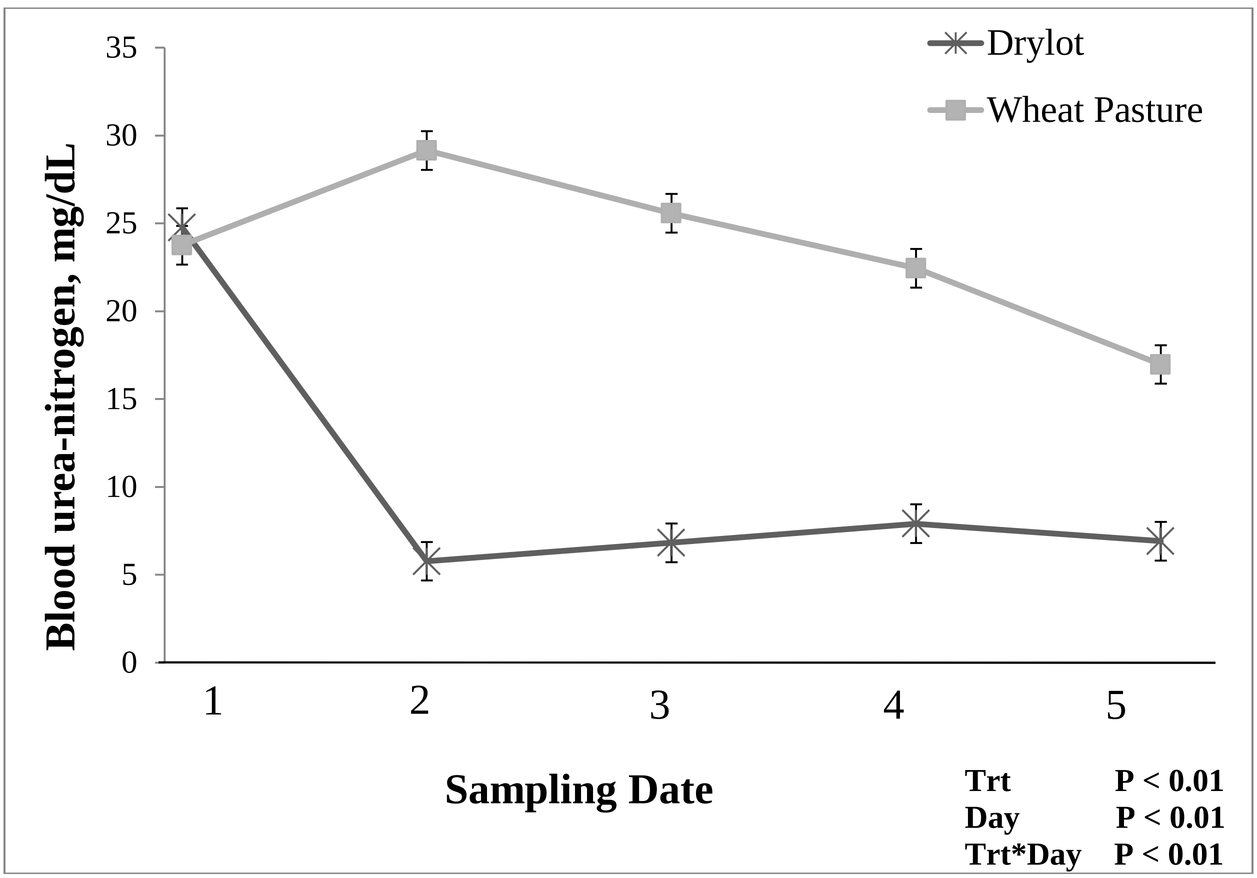

Figure 1. Blood urea-nitrogen concentrations of heifers in drylot (indicated by black line) or grazing wheat pasture (indicated by grey line). Data were pooled across yr 1 and 2 (2006-2007 and 2007-2008)

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 ± 25ng/mL) and wheat pasture group (179 ± 25ng/mL). Concentrations of IGF-I of heifers in drylot or grazed on wheat pasture decreased (P = 0.06) from 214ng/mL (first week) to 174 ng/mL (fifth week).

In the current study, final pregnancy rate of heifers was not affected bygrazing wheat pasture during breeding. . Our results indicate that grazing wheat pasture during breeding does not decrease reproductive performance. Thus, growing heifers on wheat pasture and selling bred heifers may be an acceptable way for producers to diversify their operations in the southern Great Plains.

LITERATURE CITED

Beck, P. A., S. A. Gunter, J. M. Phillips, and D. L. Kreider. 2005. Development of replacement heifers using programmed feeding. Prof. Anim. Sci. 21:365-370.

Canfield, R. W., C. J. Sniffen, and R. W. Butler. 1990. Effects of excess degradable protein on postpartum reproduction and energy balance in dairy cattle. J. Dairy Sci. 73:2342-2349.

Echternkamp, S. E., L. J. Spicer, K. E. Gregory, S. F. Canning, and J. M. Hammond. 1990. Concentrations of insulin-like growth factor-I in blood and ovarian follicular fluid of cattle selected for twins. Biol. Reprod. 43:8-14.

Elrod, C. C., and W. R. Butler. 1993. Reduction of fertility and alteration of uterine pH in heifers fed excess ruminally degradable protein. J. Anim. Sci. 71:694-701.

Ferguson, J. D., D. T. Galligan, T. Blanchard, and M. Reeves. 1993. Serum urea nitrogen and conception rate: The usefulness of test information. J. Dairy Sci. 76:3742-3746.

Horn, F. P., G. W. Horn, and H. R. Crookshank. 1977. Effect of short–term fasting and refeeding on weight and blood components of steers grazing wheat pasture. J. Anim. Sci. 44:288-294.

Lamb, G. C., J. S. Stevenson, D. J. Kesler, H. A. Garverick, D. R. Brown, and B. E. Salfen. 2001. Inclusion of an intravaginal progesterone insert plus GnRH and prostaglandin F2alpha for ovulation control in postpartum suckled beef cows. J. Anim. Sci. 79:2253-2259.

Vizcarra, J. A., R. P. Wettemann, T. D. Braden, A. M. Turzillo, and T. M. Nett. 1997. Effect of gonadotropin-releasing hormone (GnRH) pulse frequency on serum and pituitary concentrations of luteinizing hormone and follicle stimulating hormone, GnRH receptors, and messenger ribonucleic acid for gonadotropin subunits in cows. Endocrinology Vol. 138, No. 2 594-601.

Vogel, G. J., W. A. Phillips, G. W. Horn, M. J. Ford, and R. W. McNew. 1989. Effects of supplemental silage on forage intake and utilization by steers grazing wheat pasture of bermudagrass. J. Anim. Sci. 67:232-240.

Wettemann, R.P., H. D. Hafs, L. A. Edgerton, and L. V. Swanson. 1972. Estradiol and progesterone in blood serum during the bovine estrous cycle. J. Anim. Sci. 34:1020-1024.