Effects of Supplementation on Performance of Lactating First-Calf Beef Heifers

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Summary

Cattle consuming a protein block supplying rumen-undegradable protein with or without chelated copper, manganese, and zinc gained more weight during the breeding season and had increased conception rates compared to cows consuming a free-choice livestock mineral only. Intake of all products was greater than expected even though pasture quantity was not limiting. Supplying copper, zinc, and manganese as proteinates increased heifer gain but had no effect on conception or calf-weaning weight. Whether increases in conception rate are due to increased rumen undegradable protein intake or increased energy intake due to the amount of block consumed cannot be determined by this trial. Additional studies need to be carried out for this determination to be made.

Introduction

Reproductive efficiency is a major factor determining profitability for feeder calf producers. Compared to older cows, first-calf heifers take longer to return to estrus and have lower reproductive rates. Inadequate nutrition is often the cause of reduced reproductive efficiency, as first-calf heifers have increased nutrient requirements compared to older cows. Forage alone may not be adequate to meet the nutrient needs of spring-calving, first-calf heifers. Early spring fescue can be deficient in rumen undegradable protein and the trace minerals copper and zinc. This study was conducted to determine the effect of supplementing rumen undegradable protein and the trace minerals copper, manganese, and zinc in a proteinate form on the performance of first-calf heifers and their calves.

Procedures

A total of 56 lactating first-calf heifers of Simmental breeding was used in this 96-day field trial. Prior to trial initiation, male calves were castrated and all calves were individually identified and matched with their dam. At trial initiation, all first-calf heifers were in a body condition score of four. Cow body weights were taken at trial initiation, midpoint, and trial termination. Calf weights were taken at weaning in the fall. Cows were rectally palpated for pregnancy determination at weaning.

Cow-calf pairs were assigned to one of three treatments by birth date of calf. Treatments were: 1) control, free-choice mineral only (FCM) 2) protein block (PB) and 3) PB with supplemental copper, manganese, and zinc in the proteinate form (PBPM). The free-choice mineral and protein blocks were formulated to supply macro and trace minerals in amounts adequate for the NRC requirements to be met. The protein blocks were also formulated to supply rumen undegradable protein from animal by-product sources. The protein blocks were identical except for the source of copper, zinc, and manganese. A calculated composition of selected nutrients for all products is shown in Table 1. Product intake was determined by weight difference. Weight of fresh product was recorded when placed in the feeder. Product remaining in the feeder was weighed every three to five days, with the difference considered to be intake. Treatment groups were grazed in separate cool-season, grass-legume pastures. Pastures were rotated such that each treatment group received equal time in all pastures. Bulls used for breeding were also rotated between groups such that each treatment group received equal exposure to all bulls.

Growth data were analyzed by the GLM procedures of SAS. Procedures were used to account for birth date and calf sex differences between treatment groups. Differences in pregnancy percentages between treatments were analyzed using the Chi Square method.

Results and Discussion

The effect of product supplementation on gain, weaning weight, and pregnancy is shown in Table 2. Heifers fed PBPM gained more weight during the breeding season and total trial

Table 1. Calculated analysis of treatment products.

Nutrient	Free-Choice Mineral	Block + Proteinate	Block
TDN %	---------	66.4	66.4
Crude protein %	---------	20.3	20.3
Salt %	17.4	7.2	7.2
Calcium %	20.9	2.5	2.5
Phosphorus %	6.1	.7	.7
Copper, ppm	992	98.8	93.5
Zinc, ppm	2939	342	327
Manganese, ppm	2756	317	286
Selenium, ppm	52	1.79	1.79

Table 2. Effect of supplementation on heifer gain and pregnancy and calf weaning weight.

	Treatments			
Item	Control	Block + Proteinate	Block	SEM
Prebreeding gain, lb	39^a	49^a	21^b	7
Breeding season gain, lb	39^c	91^d	61^e	8
Total gain, lb	78^f	140^g	82^f	10
Percent pregnant	61.1^c	89.4^d	83.3^d	-------
Weaning wt, lb	457	490	488	13

Means in the same row with differing superscripts differ, ^{a,b}P<.1; ^{c,d,e}P<.05; ^{f,g}P<.01.

than heifers fed FCM or PB. Heifers fed PB gained more slowly than other groups prior to breeding and were intermediate in gain to FCM- and PBPM-fed heifers during the breeding season. Total gain of PB- and FCM-fed heifers did not differ. All heifers gained in body condition throughout the grazing season.

Cows fed PB and PBPM weaned heavier calves numerically than cows fed FCM; however, differences did not reach statistical significance (P = .15). The greater (P <.05) gain during the breeding period of cows receiving either block indicates greater nutrient intake. Increased nutrient intake may have stimulated milk production, resulting in numerically increased weaning weights.

Cows receiving PB or PBPM had a greater (P <.05) percent pregnant at weaning compared to cows receiving FCM only. In thin cows, conception rate can be expected to increase as rate of gain increases during the postpartum period.

Table 3. Product intake, group average, pounds per hd per day.

Intake	Treatment: Control	Block + Proteinate	Block
Initial 48 days	.347	2.08	2.04
Final 48 days	.361	5.04	4.44
Total period	.354	3.54	3.25

Group average intakes of the three products is shown in Table 3. Cows consuming FCM had greater intake than expected but were consistent during the entire period. Intakes of both block products were similar, especially during the first half of the test period. Intake increased greatly during the second half of the period even though pasture mass was not limiting. Cattle apparently liked the product and consumed more than was expected.

Reproductive Performance of Beef Females in Which Estrus and Ovulation Were Synchronized for Fixed-Time Insemination Using a Controlled Internal Drug Releasing Device, Estradiol Benzoate, and Prostaglandin $F_2\alpha$.

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Summary

One hindrance to incorporation of estrus synchronization and artificial insemination into beef cow-calf production is the limited success of estrus synchronization protocols that incorporate fixed-time inseminations. The limited success of previous protocols likely stems from the inability of these protocols to synchronize follicular growth. One hormone that can control follicular growth is estradiol. This experiment was designed to determine the effect of dose of estradiol on pregnancy rate to a fixed-time insemination in beef cattle. The estradiol was administered on the first day of progesterone exposure. After seven days the source of progesterone was removed and prostaglandin $F_2\alpha$ was administered. No effect of dose of estradiol was observed using this protocol. From these data we conclude that controlled follicular growth is not necessary for fixed-time inseminations. Further research is necessary to more accurately define the effect of controlled follicular growth in alternative protocols.

Introduction

Protocols to synchronize estrus in beef cattle were originally developed over 30 years ago to enhance the use of artificial insemination (AI). Although numerous protocols have been developed to manipulate the estrous cycle, current estimates indicate that less than 5% of beef females are bred by AI in the United States. Many factors have hindered the incorporation of estrus synchronization and AI into beef cattle production. Insemination after estrus detection is labor intensive and requires twice-daily estrus detection as well as moving and sorting individuals or groups of cows and calves for two to seven days. Many producers simply lack adequate facilities and sufficient labor to accomplish such a task. For most beef producers to implement an AI program, it is critical that the synchronization process limit labor requirements by reducing the period of AI.

One method of reducing labor requirements for AI in beef cattle is to utilize those estrus synchronization protocols that include fixed-time inseminations. Although systems for fixed-time inseminations have been available for several years, their use has been limited because of reduced fertility. New systems for fixed-time insemination have recently been reported that require handling the cattle three to four times. Approximately half of the females subjected to the fixed-time insemination conceived to the AI. Although these systems offer many advantages over other systems currently available, they are not effective in heifers. The reduced breeding performance observed in heifers may result from the inability of the hormones used to precisely control follicle growth in all females. Theoretically, control of follicle development is essential for synchronous ovulation and a successful fixed-time insemination. Thus, development of new estrus synchronization systems suitable for fixed-time inseminations is warranted. The objective of this experiment was to determine if precise control of follicular growth could enhance breeding performance of beef females and to determine the efficacy of a new system to control estrus and ovulation for fixed-time insemination.

Materials and Methods

Crossbred postpartum cows (n = 417), 2-year-old postpartum cows (n = 107), and heifers (n = 212) at four different locations were used in this experiment. On d -9 (d 0 = initiation of the breeding season) all cows received a controlled intravaginal progesterone-releasing device (CIDR; InterAg, Hamilton, New Zealand) designed for use in cattle. The CIDR device releases progesterone and is used to suppress estrus. On d -2, the CIDR was removed and all cows received 25 mg of prostaglandin $F_2\alpha$ (PGF; Pharmcia and UpJohn, Kalamazoo, Michigan) via intramuscular injection. To synchronize ovulation, cows and 2-year-olds were administered 1 mg and heifers .5 mg of estradiol benzoate (EB; Ciderol; InterAg, Hamilton, New Zealand) in peanut oil 24 hours after the removal of the CIDR device. All females were mass-inseminated 48 hours after CIDR removal. Treatments were designed to evaluate the effect of follicle control on pregnancy rates to the fixed-timed insemination. Cows and 2-year-olds were randomly assigned to treatment by calving date, while heifers were assigned to treatment by age. Treatments consisted of intramuscular administration of either 0, 1, or 2 mg of EB given at the time of CIDR insertion on d -9. Females administered 0 mg of EB would be expected to have no control of follicle growth. Administration of 1 mg of EB stimulates new follicle growth approximately one day after treatment, whereas administration of 2 mg of EB induces new follicle growth approximately two days after treatment.

All females were exposed to a 46-day natural breeding season beginning on d 14. Transrectal ultrasonography was used to determine the date of conception 90 days after AI.

Results

Conception rates to the fixed-time insemination were similar ($P > .1$) among treatments for mature cows and 2-year-old cows but tended to differ ($P = .09$) for yearling heifers (Table 1). For all three groups of females, the effects of treatment varied ($P < .05$) among locations (Table 2). Additionally, a significant ($P < .05$) treatment by location interaction was observed for the mature cows (Table 2). No difference ($P > .10$) was observed among treatments in body condition score or postpartum interval.

Discussion

A major hindrance to incorporation of estrus synchronization and AI into beef cattle production is the low fertility rate of methods that include a fixed-time insemination. Recently, new systems for fixed-time inseminations have been described and offer much promise in postpartum cows but not yearling heifers. The new systems fail to effectively time ovulation in heifers because the hormones used do not control follicular growth in all females. Administration of EB at the dosage used in this experiment has been shown to stimulate new follicular growth in both postpartum cows and heifers. We hypothesized that administration of EB on the first day of an estrus synchronization protocol would synchronize the growth of a new follicle in all females. Additionally, higher doses of EB delay the emergence of the new follicle, such that administration of 1 mg of EB stimulates new follicle growth on the following day while administration of 2 mg of EB stimulates new follicle growth two days later. Therefore, in this experiment we examined not only the importance of initiating new follicle growth but also the effect of timing of new follicular growth on conception rate to a fixed-time insemination. Data from the present experiment refute our hypothesis, in that no difference was observed among treatments in conception rate to a fixed-time insemination. Thus, it appears that controlled follicular growth does not improve the response of beef females to a fixed-time insemination.

Table 1. Pregnancy rates, postpartum intervals, and body condition scores for mature cows, 2-year-old cows, and heifers administered either 0, 1, or 2 mg of estradiol benzoate at time of insertion of a CIDR device.

Treatment	N	Body Condition Score	Postpartum Interval	Synchronization Conception Rates, %
Mature cows				
0 mg EB	142	5.7	70.4	50.0
1 mg EB	140	5.7	71.4	45.0
2 mg EB	138	5.7	71.2	48.9
2-year-old cows				
0 mg EB	37	4.9	87.5	18.9
1 mg EB	34	5.1	85.3	41.1
2 mg EB	36	5.1	84.8	27.7
Heifers				
0 mg EB	73	NA	NA	38.3
1 mg EB	67	NA	NA	47.7
2 mg EB	72	NA	NA	50.0

Treatment effects ($P > .10$).

Table 2. Conception rates to the fixed-time insemination at each location for mature cows, 2-year-old cows, and heifers administered 0, 1, or 2 mg estradiol benzoate at the insertion of a CIDR device.

Location	Treatment 0 mg EB	1 mg EB	2 mg EB	Overall
Mature cows				
A	67.3	52.9	70.0	63.3
B	54.5	47.6	47.6	50.0
C	52.7	27.0	27.3	35.8
D	15.6	51.6	38.7	35.1
2-year-old cows				
A	25.0	62.5	55.5	
B	16.6	33.3	11.7	
C	18.2	36.4	30.0	
Heifers				
A	55.0	66.7	63.2	
B	31.2	31.2	35.3	
C	45.0	50.0	45.0	
D	17.6	33.3	56.2	

Effect of location ($P < .05$).
Treatment by location interaction for mature cows ($P < .05$).

The conception rate to the fixed-time insemination in this experiment was below the level of acceptability for beef cattle producers (> 50% pregnancy rate to AI) and varied considerably among locations (range = 32-63%). The cause of varied response of females to treatment across location remains unclear but was likely due to different management and environmental conditions. Body condition score and postpartum interval varied among locations, but treatment responses could not be associated with changes in these variables. The treatment by location interaction observed in the mature cows was due to an extremely low conception rate of mature cows administered 0 mg of EB at Location D. At this location, cows had higher body condition scores and longer postpartum intervals than cows at the other three locations. Thus, a higher proportion of these cows likely had initiated estrous cycles. Administration of this protocol without controlling follicle growth could lead to the ovulation of persistent follicles. It has been well documented that fertility is low (10-20%) when insemination corresponds with the development of persistent follicles.

Administration of either dose of EB did not result in a high proportion of females conceiving to AI. Perhaps the low level of fertility was due to stimulating the ovulation of follicles that were too small. The protocol used to synchronize estrus and ovulation included administration of EB only 24 hours after removal of the CIDR device. Previous research using this protocol, excluding the second EB injection, indicated that the peak time to estrus was 48-60 hours after CIDR removal, with very few females in heat before 48 hours. Therefore, to synchronize ovulation in all females, we decided to stimulate ovulation with a second EB injection 24 hours after CIDR removal. However, it is possible that these follicles may not have been mature enough in a majority of females. Ovulation of immature follicles leads to the fertilization of an immature oocyte that is not capable of normal fertilization. Perhaps if the EB administration were delayed to 36-48 hours after CIDR removal, follicles in a larger majority of cows would be capable of ovulating a normal oocyte. Further investigation seems warranted.

In summary, stimulating new follicle growth by administering EB at the beginning of this estrus synchronization protocol does not affect conception rate to a fixed-time insemination. It is likely that the reduced fertility observed was due to ovulating follicles that were immature and not capable of high levels of fertility.

Effect of Energy and Rumensin Supplementation before and during the Breeding Season to Spring-Calving Beef Cows Grazing High- and Low-Endophyte Tall Fescue

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Summary

Endophyte level significantly affected cow weight gain in two grazing trials. Trial 1 was conducted at the University of Kentucky West Kentucky Substation and Trial 2 was in Breckinridge County. This effect was most dramatically observed in the period weight gains in Trial 2. Both endophyte level and feed supplements had a significant effect on prolactin levels during periods 2 and 3 in Trial 1. Neither feed supplementation nor endophyte level had any significant effect on pregnancy rates in either trial. There was a trend, in both trials, towards higher conception rates among cows that received feed supplements, but this difference was not statistically significant. There may be a positive effect of feed supplementation during the breeding season on the pregnancy rates of spring-calving cows, but results of these trials were inconclusive.

Introduction

The most critical period of beef cow nutrition is the time between calving and rebreeding. The spring-calving cow is at its greatest nutritional need at this stage due to lactation and winter stress. Reproduction may be compromised when cattle are not adequately fed during this period. These factors coupled with the presence of endophyte-infected tall fescue pasture can be a severe detriment to a successful breeding season. The objective of these trials was to determine the effect of supplementing energy and an ionophore (Rumensin) on the rebreeding performance of spring-calving beef cows grazing high- and low-endophyte tall fescue pasture.

Experimental Procedure

Two trials were conducted at separate locations. Trial 1, conducted at University of Kentucky's West Kentucky Substation at Princeton, consisted of 90 Angus-cross cow-calf pairs allocated in a randomized block design with six treatment combinations in a 2 x 3 factorial arrangement. Cows were blocked on postpartum interval. Pasture treatments included high-endophyte (greater than 94% infection rate) tall fescue and low-endophyte (less than 25% infection rate) tall fescue. Supplemental energy was provided to two groups of cows within each pasture treatment group. Two formulations of a 16% protein commercial pelleted feed were used. One group of cows received a formulation containing Rumensin (116.54 grams/ton), while the other

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received the formulation without Rumensin. The supplement was fed at a rate of 6 lb per head on Monday, Wednesday, and Friday of each week. The third group of cows within each pasture treatment group did not receive any feed.

The 93-day trial began on April 22 (Day 0; 30 days prior to start of breeding season) and concluded on July 24 (Day 93; end of 63-day breeding season). Treatment groups receiving supplemental feed were fed throughout the duration of the trial. Each group of 15 cow-calf pairs pastured a 15-acre paddock. Groups were rotated to a different paddock within their respective pasture treatments on Days 30 and 62 to minimize any paddock effects. One bull was turned out with each group of cows on May 22 (Day 30). Bulls were required to pass a breeding soundness exam prior to the breeding season. Bulls were also rotated to a different group on Day 62 of the trial (midpoint of the breeding season) to minimize bull fertility differences.

Blood samples for prolactin and progesterone analysis were obtained via venapucture during the trial. Progesterone analysis was used to determine the effect of treatments on overall cyclicity of cows. Progesterone samples were taken prior to the breeding season on Days 20 and 30. Prolactin analysis was conducted to study the effect of treatments on suppressing the deleterious effects of the ergot alkaloids, which may be seen through their effect on prolactin suppression. Prolactin samples were taken on Days 0, 30, and 62. Pregnancy rate and stage of pregnancy were determined by ultrasonic scan on Day 93, with a follow-up scan performed in mid-September. Cow and calf weight gain and change in cow condition scores were also recorded.

Trial 2 was conducted at Beauchamp-Alexander Farm in Hardinsburg, Kentucky. Sixty Beefmaster-cross cow-calf pairs were allocated equally in a randomized block design into three groups of 20. Cows were blocked on postpartum interval and sex of the calf. The same supplemental feed treatments were applied to two groups of cows, as in Trial 1. The third group of cows did not receive any feed.

The trial began on April 18 (32 days prior to the start of breeding season) and concluded July 25 (end of 66-day breeding season). Three 25-acre pastures were utilized in the study. Endophyte levels for the three pastures were 0%, 52%, and 85%. Cattle were rotated among these three pastures on May 20 and June 20 to minimize the variable effect of the endophyte. One bull was turned out with each group of cows on May 20. Bulls were required to pass a breeding soundness exam prior to the breeding season. Bulls were also rotated to a different group on June 20 (midpoint of the breeding season) to minimize bull fertility differences. Pregnancy rate and stage of pregnancy were determined by ultrasonic scan on September 3. Cow and calf weight gain and change in cow condition scores were also recorded.

Results and Discussion

Trial 1. Favorable weather conditions resulted in excellent forage production in all of the pastures used in the trial. Initial cow data, cow performance, and calf gain data are presented in Table 1. At the start of the trial, cows were in good flesh, with condition scores averaging from 5.1 to 5.6. Cows on low-endophyte treatments gained more weight ($P < .05$) and were in slightly better body condition at the end of the trial. Progesterone samples taken prior to the start of the breeding season determined that over half of the cows on high-endophyte treatments were cycling, whereas less than half of the cows on the low-endophyte treatments were cycling. There were no significant differences in pregnancy rate and number of days pregnant (at end of the breeding season) among treatments. Calf weight gain during the trial and actual weaning weight on October 21 were not significantly different among treatment groups.

Prolactin levels on Days 0, 30, and 62 are presented in Table 2. There were no significant differences in prolactin levels among cows on Day 0. Prolactin levels were lower ($P < .05$) for cows on high-endophyte treatments on Day 30. Cows on supplemen-

Table 1. Initial cow data, cow performance, and calf data —Trial 1. 1997—UK Princeton (April 22 - July 24).

	HE Fescue			LE Fescue		
Item	**Alone**	**Feed**	**Feed + Rum**	**Alone**	**Feed**	**Feed + Rum**
Initial cow data						
Number	14	15	15	15	15	15
Initial wt, lb	1155	1139	1100	1046	1093	1137
Initial condition score[a]	5.6	5.1	5.1	5.1	5.3	5.6
Cow performance						
Cycling (5/12-5/22), no.[b]	12	9	8	7	6	8
Gain, overall[c]	12.9	33.9	35.6	46.1	46.8	55.1
Condition score change	0.1	0.5	0.4	0.6	0.5	0.6
Pregnancy rate	14/14	13/15	14/15	12/15	15/15	15/15
Days pregnant (7/24)	46.5	53.8	49.9	45.1	47.1	40.7
Calf data						
Number	14	14	14	15	15	15
Gain (4/22-7/24), lb	207	218	209	212	204	216
Weaning wt (10/21), lb	539	542	532	538	539	546

[a]1 = emaciated; 9 = obese.

[b]Having progesterone concentration of 1 nanogram per ml in blood.

[c]Significant endophyte effect ($P<.05$).

Table 2. Least squares means for prolactin levels—Trial 1. 1997—UK Princeton (April 22 - July 24).

	HE Fescue			LE Fescue		
Item	**Alone**	**Feed**	**Feed + Rum**	**Alone**	**Feed**	**Feed + Rum**
Cow Prolactin Levels						
Prolactin, ng/ml (4/22)	208.1	112.8	131.6	142.4	112.1	107.5
Prolactin, ng/ml (5/22)[a]	224.2	111.1	91.8	220.1	276.8	255.0
Prolactin, ng/ml (6/23)[a,b]	65.0	60.0	76.4	113.5	168.6	214.5

[a]Significant endophyte effect ($P<.05$).

[b]Significant feed effect ($P<.05$).

tal feeds grazing low-endophyte pastures had the highest prolactin levels on Day 62 (P <.05).

Trial 2. Pasture conditions and available forage were adequate throughout the trial. Initial cow data, cow performance, and calf gain data are presented in Table 3. Cows used in this trial were much thinner in body condition than in Trial 1. Overall cow weight gain was highest (P <.01) for the cows receiving feed without Rumensin. There was no significant difference in overall cow weight gain between the other two treatments. Cow weight gains by weigh period were significantly affected by pasture endophyte level (P <.01). In all three weigh periods, cows grazing the 85% infected pasture gained the least amount of weight. Also, in all three weigh periods, cows grazing the 0% infected pasture gained the most weight. Pregnancy rate and days pregnant (as determined September 3) were not statistically different among the treatment groups but tended to be higher for the treatment group receiving feed with Rumensin. Calf weight gain during the trial and actual weaning weight on October 20 were not significantly different among treatment groups.

Table 3. Initial cow data, cow performance, and calf data —Trial 2. 1997 – Beauchamp-Alexander (Apr 18 - July 25).

	Feed		
Item	**None**	**Feed**	**Feed + Rumensin**
Initial Cow Data			
Number	20	20	20
Initial wt, lb	999	1042	1059
Condition score[1]	4.1	4.1	4.2
Cow Performance			
Gain, overall	117.9^a	159.9^b	101.3^a
Gain, Period 1	137.2^a (0)[2]	91.7^b (85)	125.5^a (52)
Gain, Period 2	-21.3^a (85)	31.6^b (52)	67.1^c (0)
Gain, Period 3	5.1^a (52)	36.7^b (0)	-91.3^c (85)
Condition score change	0.9	1.0	0.7
Pregnancy rate, no.	15/20	16/20	17/20
Pregnancy rate, %	75	80	85
Days pregnant (9/3)[3]	78.9	82.9	82.4
Calf Data			
Gain (4/18-7/25)	223.0	226.8	222.8
Weaning wt. (10/20), lb	562	558	552

[1]1 = emaciated; 9 = obese.

[2]Pasture endophyte level in parenthesis.

[3]Determined by ultrasound.

[a,b,c]Numbers with different superscripts differ (P<.01).