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EFFECTS OF A LONG ACTING TRACE MINERAL RUMEN BOLUS UPON RANGE COW PRODUCTIVITY [1]

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ABSTRACT: The objectives were to determine if strategic supplementation of range cows in Arizona during the last trimester of gestation with a long acting (six mo) rumen bolus containing Cu, Se, and Co would (1) increase cow body condition and body weights, and calf birth weights, weaning weights, post weaning weights, or weight per day of age (WDA); and (2) to see if any of the above traits varied by breed. There were 192 control and 144 treated Composite cows (25% Hereford, Angus, Gelbevieh, and Senepol or Barzona), 236 control and 158 Hereford treated cows, and 208 control and 149 treated Brahman cross cows used over three years. Cows were weighed and scored for body condition (1 to 9, 9 = fattest) in January, May, and September. Data were analyzed using a restricted maximum likelihood-based, mixed effects model appropriate for repeated measures. The statistical models included the fixed effects of treatment, breed of cow, and year, and all two and three way interactions between those, and age of dam and calf sex and their interaction. Cow within breed by bolus was included as a random effect. The continuous fixed effect of weaning age was included in the model. Control cows lost less weight ($P < 0.05$) than treated cows from January to May (- 10 ± 3.4 vs - 21 ± 4.0 kg), but there was a significant breed by year by treatment interaction ($P < 0.001$). Calf WDA, weaning, and post weaning weights did not differ ($P > 0.05$) between treated and control cows, however there was a significant ($P < 0.05$) breed by year by treatment interaction for birth weight. Strategic supplementation via a long acting trace mineral bolus increased or decreased body weight in early lactation cows, depending upon the breed and year and may indicate the need for breed and year specific supplementation programs.

Key Words: Cattle, Minerals, Copper, Selenium

Introduction

A long acting (6 mo) rumen trace mineral bolus containing Cu, Se, and Co has been developed in the United Kingdom (Cosecure®, Telsol Ltd., Leeds, United Kingdom) and has shown promise for helping alleviate trace mineral deficiencies (Buckley et al., 1987; Givens et al., 1988) though calf growth did not differ for the one study in which it was measured (Givens et al., 1988). If the long acting rumen bolus can be shown to be successful on Arizona rangelands, then cattle dosed with the boluses could pack their own trace mineral supplement for up to six mo instead of having to deliver an oral trace mineral supplement to the cattle by pack horse for rugged topography Arizona rangelands.

A companion study in this proceedings (Sprinkle et al., 2004) examines the effect of the Cosecure® bolus upon cow and calf trace mineral profiles. In this paper, we will examine the effect of the trace mineral bolus upon cow and calf productivity. Specifically, we wished to determine if strategic supplementation of range cows in Arizona during the last trimester of gestation with a long acting (six mo) rumen bolus containing Cu, Se, and Co would (1) increase cow body condition and body weights, and calf birth weights, weaning weights, post weaning weights, or weight per day of age (WDA) at weaning; and (2) to see if any of the above traits varied by breed within treatment.

Materials and Methods

Range site. The study site for this experiment was at the 32,161 ha V-V Ranch operated by the University of Arizona and located near Camp Verde, Arizona. The ranch ranges in elevation from approximately 975 m to 2195 m. Average yearly precipitation ranges from 40 cm at the lower elevations to 70 cm at the upper elevations. However, annual precipitation during the course of this trial was quite variable, with above average precipitation during the growing season in 2001, below average precipitation during the growing season in 2002, and above average precipitation during March and June 2000 and mostly below average summer precipitation in 2000.

Forage Sampling. Forage was sampled by hand clipping four times a year (January, April, June or August, and September) from four different locations on the ranch and analyzed for Cu and Se according to the methods described in this proceedings (Sprinkle et al., 2004).

Animals. The trial commenced in January 2000 and concluded in September 2002. Treatment and control cattle were randomly allocated at the onset and remained in each treatment group throughout the three-yr trial. Control and treatment cattle over the three-yr trial included 192 and 144

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[1]We acknowledge the support of the Arizona Experiment Station; Texas Agricultural Experiment Station; Mesquital Livestock Service, Tucson; and Telsol Ltd, manufacturer of Cosecure®, P. O. Box HH7, Leeds, United Kingdom LS8 2YE. Mention of a proprietary product does not constitute a guarantee or warranty of the product by Arizona Experiment Station, University of Arizona, Texas Agricultural Experiment Station, Texas A & M University, Colorado State University, or the authors and does not imply its approval to the exclusion of other products that may also be suitable.

Composite (**C**) cows (25% Hereford, Angus, Gelbevieh, and Barzona or Senepol), 236 and 158 Hereford (**H**) cows, and 208 and 149 Brahman (**B**) cross cows, respectively. Cows ranged in age from 2 to 8, 2 to 18, and 2 to 15 yr for C, H, and B, respectively.

In January of each yr, cows in the treatment group were orally dosed with two 100 gram Cosecure® boluses consisting of 0.30% (wt/wt) selenium as sodium selenate, 13.4% (wt/wt) copper, and 0.5% (wt/wt) cobalt. According to company literature validated with rumen fistulated cattle on a silage and concentrate ration, boluses dissolved in 175 days and released 156, 5.9, and 3.4 mg/d of Cu, Co, and Se, respectively.

Cattle remained in a common herd and rotated through 32 upland pastures without any type of oral trace mineral supplement for the three years of the trial except for free choice white iodized salt blocks. In the winter of 2002, from early February to late April 2002, cows were provided free pasture access to protein blocks (27% crude protein; Eagle Milling Co., Inc., Casa Grande, AZ) containing 17 ppm Cu and 0.301 ppm Se. At an average daily intake of 0.88 kg of protein supplement, it was estimated that cattle received 15 mg/d Cu and 0.26 mg/d Se from the protein supplement.

The majority (98.2%) of calves born in this trial were sired by Hereford bulls via artificial insemination or pasture exposure. The breeding seasons extended from May 20 to November 15 in 2000, from May 16 to October 31 in 2001, and June 29 to October 26 in 2002. For a portion of the cow herd (56, 43, and 67% for C, H, and B over the three-yr trial, respectively), the natural exposure breeding season was preceded by estrus synchronization and artificial insemination using both OV-SYNCH and Select SYNCH in 2000 and 2001 and Easi-Breed CIDRs in 2002. In September and January, cows were checked for pregnancy by rectal palpation. Cattle were weighed and scored for BCS (1 to 9; 9 = fattest) in January, May, and September. Birth and weaning weights were collected on all calves. The majority of the calves were weaned in September at approximately 184 d and weaning weights were adjusted to 205 days of age and for age of dam according to BIF (1990) guidelines. In 2000, all calves were shipped to the University of Arizona Feedlot (UAF) 3 days after weaning. In 2001 and 2002 ten days after weaning, larger steers were shipped to UAF while smaller steers and all the heifers were shipped to the Maricopa Agricultrual Center where they were placed on Sudan pasture. Calves too young to wean in September were weaned in late November 2000, early December in 2001 and mid-November in 2002.The WDA for each calf at weaning was calculated using the actual weaning weights and dividing by age at weaning.

Statistical Analyses. Data were analyzed using a restricted maximum likelihood-based mixed effects model appropriate for repeated measures (SAS Inst., Inc., Cary, NC) with fixed effects of treatment, cow breed, year, and all two and three way interactions between those, and Beef Improvement Federation (BIF, 1990) age of dam and calf sex and their interaction. The continuous fixed effect of weaning age was included in the model and cow within breed by bolus was included as a random effect. An unstructured correlation structure was used to model within subject error. Treatment means for all statistical models were separated using all pairwise tests using unprotected least squares difference tests.

Results

Overall Forage Trace Mineral Concentrations. Concentrations of Cu in forage were nearly adequate (10 ppm; NRC, 1996) in 2000 (9.2 ± .46 ppm), marginally deficient in 2002 (4.9 ± .45 ppm), and severely deficient in 2001 (3.9 ± .46 ppm), a year with more favorable precipitation during the growing season. The concentrations of Se in acted in an opposite fashion to that of Cu, being 0.042 ± .006 ppm in 2000, 0.079 ± .006ppm in 2001, and 0.045 ± .006 ppm in 2002), though the concentrations of Se were always deficient in forage (< 0.1 ppm; NRC, 1996).

Cow Performance Data. Over the course of the trial, BCS for treatment cows tended ($P = 0.07$) to be greater for treatment cows in January but cow weight in January did not differ ($P = 0.3655$; Table 1). The BCS in May and September did not differ ($P > 0.32$), though bolused H cattle had less BCS ($P = 0.0006$) than did control H in May 2000 (4.5 ± .13 vs 5.0 ± .10).

There were no significant overall differences by treatment in cow weights (Table 1) but the year x breed x treatment interaction was important ($P < 0.0001$) for cow weight in May. Most of this interaction was due to control H cattle having greater body weight in May than did bolused H cattle ($P < 0.0001$; 448 ± 7.2 vs 396 ± 9.6 kg). By September, the interaction of cow breed with year and treatment had diminished ($P = 0.1071$) and the only significant difference ($P = 0.0268$) occurred in September 2001, when control C cattle had greater weights than did treated cows (465 ± 6.7 vs 444 ± 2.7 kg).

Cattle treated with Cosecure® boluses lost more weight from January to May ($P = 0.0200$; Table 1). A highly significant ($P = 0.0004$) year x breed x treatment interaction was present and is presented in Figure 1. By far ($P < 0.0001$), H cattle were most profoundly affected by bolus administration in 2000, a better Cu yr. Treated B cattle also tended ($P = 0.0543$) to lose more weight than control in 2002.

There are at least two assumptions that can be made as to why bolused cattle lost more weight in early lactation. First, it can be assumed that bolused cattle had greater milk production than did control cattle. Alternately, it can be assumed that increased supplemental Cu (especially when forage Cu levels were close to dietary requirements in 2000) could have had an antagonistic effect upon cow productivity by interacting with other trace minerals in the forage base or by decreasing forage digestibility (Arthington et al., 2003).

Limited experimental research has examined the influence of added Cu and Se in the diet upon milk production. Lacetera et al. (1996) reported that milk production ($P = 0.06$) and total milk solids ($P = 0.02$) were greater for dairy cows provided supplemental Se. Engle et al. (2001) failed to show any increase in milk production with added Cu in the diets of dairy cattle.

Although some research has shown a decrease in forage digestibility with added Cu (Arthington et al., 2003), other researach (Lopez-Guisa and Satter, 1992) failed to demonstrate the same effect.

Since we were unable to obtain milk production for these cattle, it is uncertain whether the decline in BCS for bolused cattle resulted from increased milk production or antagonisms with other trace minerals in the diet and/or reduced fiber digestibility.

Calf Performance Data. In this study, we failed to demonstrate any added growth for adjusted weaning weights or WDA for calves suckling cows bolused with a long acting trace mineral bolus (Table 2). Other research has reported variable results for added Cu, increasing ADG during finishing trials (Ward and Spears, 1997) and decreasing gain for growing dairy heifers (Lopez-Guisa and Satter, 1992). Awadeh et al. (1998) and Gunter et al. (2003) failed to demonstrate any added growth performance for calves nursing Se supplemented cows while Nelson and Miller (1987) reported that weaning weights for calves nursing Se supplemented cows increased by 20 kg.

It appears that any added weight gains for calves nursing cows supplemented with either Cu or Se are dependent upon several factors, chief of which are the dietary Cu or Se concentrations for cows in the study and the presence or absence of any antagonistic trace minerals in the diet such as Mo, Fe, and S. Villar et al. (2002) reported that positive growth responses appear to occur when dietary Se in the forage base is less than 0.05 ppm DM and when plasma Se levels are less than 0.030 ppm. The pasture forage Se reported by Gunter et al. (2003) was 0.11 ppm and 0.07 ppm by Awadeh et al. (1998).

There was a trend (*P* = 0.0675; Table 2)for increased post weaning ADG for H calves from supplemented cows. Most of this response occurred (*P* = 0.0892) in 2001(179 ± 8.1 vs 200 ± 9.5 kg) when Cu concentrations in forage were severely deficient and Se concentrations slightly elevated (though still below adequate levels).

We detected a year x breed x treatment interaction (*P* = 0.022) for birth weight, due mostly to B cattle in 2001 (*P* = 0.0170; 37.2 ± .63 and 35.4 ± .68 for control vs bolused cows) and C cattle in 2000 (*P* = 0.0735; 37.2 ± .54 vs 35.8 ± .63 for control vs bolused cows). We are uncertain for the nature of this effect unless it was related to forage digestibility factors discussed earlier.

Implications

Cow and calf performance responses to added Cu and Se varied with yr and by breed, necessitating careful monitoring of levels of these trace minerals in the forage during different growing conditions and altering trace mineral supplementation programs accordingly.

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Table 1. Effects of a long acting trace mineral bolus upon range cow weight and body condition score[a]

Item	No Bolus	Bolus	*P*-value
January BCS[b]			
All cows and all yr	4.8 ± .05	4.9 ± .06	0.0738
C cows, over all yr[c]	4.6 ± .08	4.7 ± .09	0.1783
H cows, over all yr[c]	4.8 ± .08	4.9 ± .08	0.0694
B cows, over all yr[c]	5.0 ± .09	5.1 ± .10	0.0600
May BCS[b]			
All cows and all yr	4.5 ± .11	4.4 ± .12	0.3283
C cows, over all yr[c]	4.6 ± .18	4.3 ± .20	0.1559
H cows, over all yr[c]	4.5 ± .21	4.4 ± .21	0.8642
B cows, over all yr[c]	4.5 ± .19	4.5 ± .22	0.8616
September BCS[b]			
All cows and all yr	4.6 ± .05	4.7 ± .06	0.5162
C cows, over all yr[c]	4.5 ± .08	4.5 ± .09	0.8543
H cows, over all yr[c]	4.5 ± .07	4.6 ± .09	0.2051
B cows, over all yr[c]	4.9 ± .09	5.0 ± .10	0.9388
January wt, kg			
All cows and all yr	445 ± 3.3	449 ± 3.8	0.3655
C cows, over all yr[c]	432 ± 5.5	426 ± 6.4	0.3811
H cows, over all yr[c]	435 ± 5.2	445 ± 5.8	0.1737
B cows, over all yr[c]	467 ± 6.0	475 ± 6.7	0.2740
May wt, kg			
All cows and all yr	436 ± 3.8	426 ± 4.4	0.1293
C cows, over all yr[c]	421 ± 6.7	407 ± 7.5	0.1481
H cows, over all yr[c]	442 ± 5.6	433 ± 6.6	0.2922
B cows, over all yr[c]	438 ± 6.9	437 ± 7.7	0.8993
September wt, kg			
All cows and all yr	435 ± 3.3	434 ± 3.7	0.8823
C cows, over all yr[c]	427 ± 5.8	413 ± 6.6	0.1021
H cows, over all yr[c]	431 ± 4.9	436 ± 5.8	0.4954
B cows, over all yr[c]	447 ± 6.0	453 ± 6.6	0.4100
Change in wt January to May, kg			
All cows and all yr	- 10 ± 3.4	- 21 ± 4.0	0.0200
C cows, over all yr[c]	- 9 ± 5.6	- 17 ± 6.6	0.2999
H cows, over all yr[c]	2 ± 5.6	- 13 ± 6.4	0.0713
B cows, over all yr[c]	- 23 ± 6.0	- 32 ± 6.7	0.2353

[a] Cosecure® trace mineral boluses had an expected life of approximately 175 d and provided approximately 156 mg/d Cu, 5.9 mg/d Co, and 3.4 mg/d Se.

[b] (1 to 9, 9 = fattest)

[c] Breeds: C = Composite (25% Hereford, Angus, Gelbevieh, and Barzona or Senepol); H = Hereford; B = Brahman cross

Table 2. Weight per day of age, birth, adjusted weaning, and post-weaning wt for calves nursing cows administered a long acting trace mineral bolus[a]

Item	No Bolus	Bolus	*P*-value
Adjusted weaning wt, kg[b]			
From all cows and all yr	201 ± 1.9	199 ± 2.1	0.5201
From C cows, over all yr[c]	210 ± 3.1	211 ± 3.6	0.8148
From H cows, over all yr[c]	177 ± 2.8	177 ± 3.3	0.9739
From B cows, over all yr[c]	215 ± 3.4	210 ± 3.7	0.1872
November post-weaning wt, kg			
From all cows and all yr	181 ± 3.4	184 ± 3.5	0.4016
From C cows, over all yr[c]	193 ± 5.4	194 ± 5.3	0.9370
From H cows, over all yr[c]	155 ± 5.2	169 ± 6.3	0.0675
From B cows, over all yr[c]	194 ± 5.3	190 ± 5.4	0.4424
Wt/d of age at weaning, kg			
From all cows and all yr	0.95 ± .01	0.94 ± .01	0.5959
From C cows, over all yr[c]	0.99 ± .01	1.00 ± .02	0.7866
From H cows, over all yr[c]	0.84 ± .01	0.84 ± .02	0.9599
From B cows, over all yr[c]	1.01 ± .02	0.99 ± .02	0.2154
Birth wt, kg			
From all cows and all yr	35.4 ± .27	34.9 ± .27	0.5167
From C cows, over all yr[c]	35.4 ± .41	35.4 ± .45	0.5223
From H cows, over all yr[c]	34.9 ± .41	34.9 ± .45	0.6972
From B cows, over all yr[c]	35.8 ± .45	34.9 ± .50	0.3700

[a] Cosecure® trace mineral boluses had an expected life of approximately 175 d and provided approximately 156 mg/d Cu, 5.9 mg/d Co, and 3.4 mg/d Se.

[b] Weaning weights adjusted according to Beef Improvement Federation guidelines (BIF, 1990).

[c] Breeds: C = Composite (25% Hereford, Angus, Gelbevieh, and Barzona or Senepol); H = Hereford; B = Brahman cross

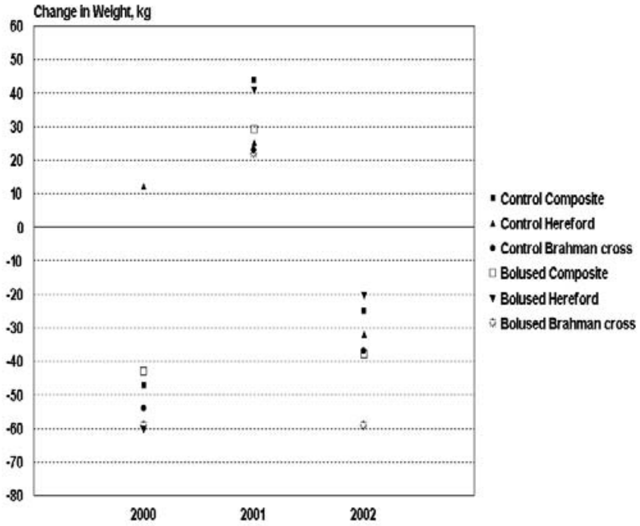

Figure 1. Change in wt from January to May over three yr for beef cowbreeds administered a long acting (6 mo) trace mineral bolus. By breed and yr, Hereford cattle differed by treatment in 2000 (*P* < 0.0001) and Brahman cross cattle tend (*P* = 0.0543) to differ in 2002.