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Effects of Zeranol and Monensin on Reproductive Performance of Replacement Heifers[1]

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Abstract

Effects of zeranol and monensin, alone or in combination, on replacement heifer growth and reproductive performance were investigated. Over a period of 6 yr, 311 Hereford × Angus heifers were stratified by age and weight at weaning randomly assigned to one of four treatments: control (C); two 36-mg implants of zeranol administered on d 1 and 96 (Z); 200 mg of monensin, daily (M); or zeranol + monensin (ZM). Diets included meadow hay + 1.4 kg barley + .05 kg of biuret during the 196-d wintering phase. Initial weights averaged 166 kg. Heifers in the M and ZM treatments had 18% greater ($P<.05$) ADGs than those in C or Z. Age at first estrus was younger ($P<.05$) for implanted heifers compared to heifers not implanted. First breeding conception rates were reduced ($P<.05$) for Z and ZM compared to C and M while second breeding conception rates also differed with M and Z heifers higher ($P<.05$) than C and ZM. Age at conception in the first breeding was older ($P<.01$) for Z- and ZM-treated heifers than C or M. Calving interval for Z was shorter ($P<.01$) than C but not different ($P>.1$) from M or ZM. Zeranol increased ($P<.05$) the attrition rate of heifers by over 50% compared to C and M in the first calving year. Second breeding attrition rate was higher ($P<.01$) for C and ZM treatments than for M or Z.

Pelvic size tended to be larger ($P<.1$) at time of breeding in ZM heifers and incidence of dystocia was lower ($P<.05$) in implanted heifers. Results indicate that two implants of zeranol reduced first calf conception rate, delayed conception, and decreased age of first estrus. An increased attrition rate within the first year was also observed in implanted heifers. Monensin appeared to counteract some of the negative effects of zeranol on reproductive performance and reduced culling rates over the first two calving seasons.

(Key Words: Beef Heifers, Zeranol, Monensin, Reproductive Rate.)

Introduction

Growth-promoting implants, such as zeranol, have proven to be an economically feasible method of increasing growth rates of young cattle (1, 2). With this potential for increased economic return, many producers are implanting steer and heifer calves. Some implanted heifers are retained in the herd or sold as replacements. Zeranol is not approved for use in breeding stock; therefore, it is important to know if there are detrimental effects on reproductive performance of replacement heifers that have been implanted with growth promotants. Researchers have reported decreased conception rates in heifers with single (3, 4) as well as multiple zeranol implants (5, 6). However, Simms et al. (3) and Muncy et al. (5) reported that single implants at 2.5 and 1.5 mo of age, respectively, did not affect conception rates. Heifers implanted at 8 and 11 mo of age had increased pelvic size compared to controls in a study conducted by Stagmiller et al. (6). No increase in heifer weight or pelvic size was observed by Anthony et al.; however, zeranol-treated heifers had an increased abortion rate compared to controls (7).

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Supplementation of feed additives such as monensin have improved feed efficiency in grazing (8) and feedlot animals (9). Monensin-supplemented heifers have shown improved reproductive performance by having higher conception rates (10), earlier first-observed estrus (11, 12, 13), and heavier calves at weaning (14, 15).

Therefore, this study was designed to test the effects of monensin and zeranol, alone and in combination, on gains and feed efficiency of replacement heifers and the subsequent effects on reproductive performance and heifer productivity.

Materials and Methods

Over the 6-yr study, 311 Hereford × Angus heifers were stratified by age and weight, then randomly assigned to one of four treatments. The heifers were born in March and April with a mean birth date of April 2, weaned on September 11, and removed from the range and put on meadow aftermath and/or rake-bunched hay. At this time heifers were hand fed a barley-biuret supplement and offered 1.4 kg of barley and .05 kg of biuret/d. On October 23, heifers were weighed after an overnight fast from feed and water and then allotted to treatments.

Treatments included a control group that received no zeranol implant or monensin (C), a zeranol group that received a 36-mg implant on d 1 and 96 (Z), a group that were fed monensin at the rate of 200 $mg^{-1}{\cdot}d^{-1}$ (M), and a group that received both the zeranol implants and the monensin (ZM). All groups received meadow hay free choice and the barley-biuret supplement during the 196-d treatment period which terminated on May 7.

Heifers were weighed every 28 d after an overnight fast. A trace mineralized salt, bone meal, and salt mixture along with water was available at all times. This was presented in a two-compartment box with trace mineralized salt in one-half and a mix of 50% trace mineralized salt and 50% bone meal in the other half. Heifers were penned by treatment and fed in covered feed bunks with hay weighed daily and orts weighed back weekly. The barley-biuret supplement, without the monensin, was fed through the breeding season.

Visual heat checks were made through late January. Teaser animals were then injected with testosterone propionate and fitted with chin ball markers to aid in heat detection. Dates of first estrus as well as subsequent estruses were recorded to determine estrus interval. (A 15- to 26-d cycle was considered normal.) At the end of the wintering phase, heifers were injected with prostaglandin F2α with a second injection given 11 d later. In the first 2 yr, heifers observed in estrus were bred artificially between injection dates and for 4 d following the second injection. All heifers not bred at that time were inseminated with visual heat detection continuing. Natural service was used for a 10-d period and artificial breeding resumed for an additional 10 d. Bulls were again used for the following 10-d period and artificial breeding resumed for 2 wk, terminating on July 11 when natural breeding was again utilized for 10 more days. In the third and fourth years, heifers again received two injections of prostaglandin F2α 11 d apart, but were bred naturally for a total of 65 d. During the fifth and sixth years heifers were injected with prostaglandin F2α as described previously and artificially bred for 7 d following the second injection, based on heat detection. Natural breeding or artificial insemination continued for an additional 58 d. Artificial insemination, based on heat detection, was used during the periods when the heifers were expected to come into estrus as a result of synchronization, and natural breeding was used to provide coverage of heifers not synchronized. Pelvic measurements were taken at breeding, using a Rice Pelvimeter, and recorded. The horizontal diameter of the pelvis was determined by measuring the widest part between the right and left ilium bones of the pelvis. The vertical reading was determined by measuring the distance from the pubic spine to the sacrum between the 2nd and 3rd sacral bones. This was done during the final 2 yr of the study only.

Heifers were placed on range prior to breeding and remained there until late fall when they were pregnancy checked via rectal palpation. All open heifers were eliminated from the study. Each following spring, heifers were weighed within 24 h after parturition. Calf weight, dystocia score, and calving date were also recorded. Calf weaning weights were recorded and adjusted for sex based on the entire research unit herd. Heifer weights were also recorded at weaning and again at pregnancy check time in early October. The breeding

TABLE 1. Feed efficiency and ADG of heifers during a 196-d winter treatment period.

Treatment	Number	Initial weight	ADG[a]	Feed intake[b]	Feed efficiency[a]
		(kg)			
Control	78	166	.46 ± .08[c]	6.6	6.6 ± 1.4[c]
Zeranol	77	166	.45 ± .07[c]	6.4	6.5 ± 1.1[c]
Monensin	78	165	.56 ± .08[d]	6.6	5.3 ± 1.0[d]
Zeranol + monensin	78	165	.56 ± .08[d]	6.4	5.1 ± 0.9[d]

[a]Mean ± standard error.

[b]Feed intake includes 1.45-kg supplement.

[c,d]Means within a column with different superscripts differ ($P<.1$).

for the second calf was similar to the first year but began 2 to 3 wk later in conjunction with the main cow herd. Data collected at second calving was the same as with the first calf, and calving interval was calculated. The animals were culled if open at pregnancy check time or for health problems, such as prolapse or paralysis from parturition.

Statistical analysis was conducted using the General Linear Model procedure of SAS (16). The model included the effects of year, treatment, and year × treatment interaction. The treatment × year interaction was not significant ($P>.1$). Contrasts tested were zeranol vs. control, monensin vs. control, zeranol + monensin vs. control, the mean of monensin, zeranol, and zeranol + monensin vs. control, and monensin vs. zeranol. Due to unequal replications within treatments from open animals being dropped from the study, the Type 3 sums of squares was used to test treatment differences.

Results and Discussion

Weight gain and feed efficiency data for the 196-d treatment period are presented in Table 1. Heifers fed monensin averaged .10 kg greater ($P<.1$) ADG over heifers not fed monensin. Feed intake was similar for all treatments; however, M heifers had a 20% improved efficiency. Zeranol had no effect on ADG or feed efficiency. Heifers implanted with zeranol tended to weigh more ($P<.1$) at calving than nonimplanted animals (Table 2). At weaning of the first calf, heifer weights on all treatment groups were heavier ($P<.05$) than C.

Implanted heifers were younger ($P<.05$) at first estrus (Table 2) but conceived at an older age ($P<.01$). The incidence of abnormal heat cycles was also increased ($P<.01$) in implanted heifers. Monensin-fed heifers also had an increased ($P<.05$) incidence of abnormal heat cycles over C, but fewer ($P<.05$) than implanted heifers. Higher ($P<.05$) conception rates were observed for C- and M-treated heifers when compared to the implanted groups. At pregnancy check time in October the reproductive tracts of the open heifers were also evaluated. The number of immature tracts tended to be greater in implanted heifers, although this difference was not significant. Heifers conceiving were maintained in the study for a second breeding year. The conception rates for the second calf were higher ($P<.05$) for Z- and M-treated heifers. Calving interval was shorter ($P<.05$) for the Z treatment group.

Birth weights (Table 3) of the first and second calves were similar ($P>.10$) among treatments. Sex-adjusted weaning weights were greater ($P<.05$) for the M treatment group. Second calf weaning weights were lower ($P<.05$) for the ZM

TABLE 2. Reproductive performance data.

Treatment	Age at first estrus[a]	Abnormal heat cycles[b]	First calf conception rate	Age at conception[a]	Calving interval	Heifer wt at calving	Heifer wt at weaning
	(d)	(%)		(d)		(kg)	
Control	411 ± 33[c]	8[e]	87[d]	436 ± 13[d]	395 ± 12[c]	326 ± 7.3[c]	336 ± 6.3[c]
Zeranol	407 ± 23[d]	38[c]	58[c]	445 ± 10[c]	379 ± 14[d]	334 ± 8.8[c]	351 ± 14.7[d]
Monensin	412 ± 16[c]	19[d]	87[d]	431 ± 7[d]	392 ± 14[c]	323 ± 6.1[c]	345 ± 8.4[d]
Zeranol + monensin	404 ± 19[d]	46[c]	69[c]	444 ± 10[c]	391 ± 18[c]	332 ± 4.3[c]	347 ± 8.5[d]

[a]Mean ± standard error.

[b]Represents only those heifers observed in estrus; 7, 15, 6, and 11 heifers were not detected in the control, zeranol, monensin, and zeranol + monensin groups, respectively.

[c,d,e]Means within a column with different superscripts differ ($P<.05$).

TABLE 3. First and second calf birth weights and sex-adjusted weaning weights[a].

Treatment	Birth weight First	Birth weight Second	First calf weaning weight sex adjusted	Second calf weaning weight sex adjusted
Control	33	35	138^{b}	146^{b}
Zeranol	34	35	133^{d}	140^{b}
Monensin	34	35	142^{c}	144^{b}
Zeranol + monensin	34	34	132^{d}	135^{c}

[a]All weights in kg.

[b,c,d]Means within columns with different superscripts differ ($P<.05$).

treatment with no difference between the other groups.

Pelvic area and dystocia were recorded in the final 2 yr of the study. Pelvic area was measured at the beginning of the breeding season and showed ZM heifers tended to have a larger pelvic opening. However, Z heifers were similar to C and M. Heifers implanted with zeranol had a lower ($P<.05$) incidence of dystocia than nonimplanted animals (Table 4).

Attrition rates (Table 4) were greater ($P<.01$) in the first year for Z and M heifers compared to C and M heifers. Second-year culling rates were higher ($P<.05$) for the C and ZM treatment groups. The lowest culling rate was observed in the M treatment group for both years, and therefore more animals were available for subsequent breedings.

The lack of response to zeranol over the winter period is in contrast to previous studies conducted using zeranol implants (1, 2). However, implanted animals were heavier at calving time; this may be due to a delayed response to zeranol or an increased compensatory gain when placed on pasture. The higher weights of implanted heifers at parturition was no longer evident at weaning ($P>.10$).

With the earlier exhibition of estrus observed in the implanted heifers, one might conclude that zeranol could be used to promote puberty at an earlier age. This possible advantage is confounded by an increased incidence of abnormal heat cycles. Thus, early heat was apparently a nonovulatory estrus or possibly early absorption of the fetus, thereby allowing a return to estrus results in conception at a later date. The increased abnormal estrus cycles made the artificial insemination program used in this study more difficult and expensive due to increased services, labor, and amount of semen used. The lower conception rate for implanted heifers and length of cyclic period may have inflated the number of abnormal cycles due to multiple abnormal cycles from the same animals. Lower conception rates of implanted heifers have been observed in other research (5, 17).

The shortened calving interval may have been due to the implanted heifers being heavier at calving. The added condition may have shortened the anestrus period. However, the implanted heifers also calved at a later date and therefore had more of an opportunity to shorten their calving interval. This is especially true since the second breeding season began 2 to 3 wk later in the second year and the early calvers may have been cycling but had no opportunity to breed earlier.

There was also a decreased incidence of dystocia in implanted heifers which agrees with results reported by Staigmiller et al. (6). Heifers in the ZM treatment tended to have larger pelvic openings, but Z heifers were not different from other treatments. However, implanted heifers were older and larger at calving due to delayed conception and this may have contributed to reduced dystocia. Since heifers that failed to conceive were eliminated from the study, the lower conception rate of implanted

TABLE 4. Dystocia and attrition rate of heifers.

Treatment	Pelvic area (cm^{2})	Dystocia (%)	First year attrition (%)	Second year attrition (%)	Remaining in herd for 3rd year (%)
Control	187 ± 1.9^{b}	75^{b}	18^{b}	51^{b}	32^{c}
Zeranol	190 ± 6.4^{b}	57^{c}	40^{c}	36^{c}	39^{c}
Monensin	190 ± 0.3^{b}	75^{b}	18^{b}	31^{c}	56^{b}
Zeranol + monensin	201 ± 8.8^{b}	52^{c}	35^{c}	53^{b}	28^{c}

[a]Means ± standard error.

[b,c]Means within a column with different superscripts differ ($P<.05$).

TABLE 5. Production per heifer over the first two calvings.

Treatment	First calving[a]	Second calving[b]
	(kg)	
Control	120[c]	62[d]
Zeranol	77[d]	59[d]
Monensin	124[c]	83[c]
Zeranol + monensin	91[d]	48[d]
Standard error	22.7	14.6

[a]Total weight of calves weaned divided by number of heifers exposed to breeding.

[b]Total weight of calves weaned divided by number of heifers exposed to breeding the first year.

[c,d]Means within a column with different superscripts differ ($P<.05$).

heifers severely reduced the number of parturitions.

Productivity of a beef heifer or cow is dependent on the ability to conceive and deliver a calf every year as well as the size of calf she weans. Heaviest first calves were weaned by heifers in the M treatment. Second calves were lighter in the ZM treatment with no differences among other treatments. In a study conducted by Deutscher et al. (18), no differences were observed in weaning weights between implanted and control heifer's calves. Morrison et al. (14) reported heavier 205-d adjusted weaning weights of calves from heifers implanted at weaning and reported increased udder development and milk production, which may have increased weaning weights. Monensin has also been found to increase calf weaning weights (15). Productivity for the first calf was determined as kg of calf weaned per heifer exposed and was higher ($P<.05$) for C and M heifers than for Z and ZM heifers. Productivity of the second year was determined by the percent of heifers remaining from the first year multiplied by the conception rate and the average weaning weight for each treatment. Heifers in the M treatment had the highest ($P<.05$) second-year production. Production per heifer for both years is reported in Table 5.

Attrition rate, due primarily to failure to conceive, is one of the major factors affecting the profitability of beef heifers. Control and monensin heifers had a lower attrition rate for the first year. Therefore, more animals were maintained in the breeding herd for the subsequent year. The monensin-fed heifers had a higher conception rate in both years of the study and more remained in the herd for subsequent years. Higher conception rates with monensin were also observed by Mosley et al. (10). Post-calving nutrition of heifers is critical for maintaining adequate condition for a high conception rate in the second breeding season. These results indicate that feeding monensin can help maintain a higher conception rate through the first 2 yr of a heifer's reproductive life.

Implications

The productivity of a cow is a life span measurement and includes the number of calves produced and weaned, and calf weaning weight. Zeranol implantation at 7 and 10 mo of age can negatively affect reproductive performance. Lower conception rates, increased odd heat cycles, increased age at conception, and a higher rate of attrition were observed in zeranol-implanted heifers. Monensin, fed during the first winter, had a positive effect on reproductive performance, and when fed to implanted heifers, tended to lessen the negative effects of zeranol on conception rates. Monensin increased heifer productivity by increasing the weaning weight and decreasing the attrition rates for the first two breedings.

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