Effects of growth-promoting implants administered during the suckling phase or at weaning on growth and reproduction in replacement beef heifers grazing native range

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INTRODUCTION

The beef industry has used growth-promoting implants as a means to increase body weight (BW) gains and potentially increase efficiency. Growth-promoting implants, however, have not been previously recommended for use in replacement heifers. Ralgro and Synovex C have been reported to increase BW gains and yearling pelvic area (Staigmiller et al., 1983; Hancock et al., 1994), with no negative effect on puberty attainment (Hancock et al., 1994). However, there are discrepancies in the literature regarding the impact of growth-promoting implants on fertility and subsequent pregnancy rates. Previous research has reported both no difference in pregnancy rates among non-treated controls and heifers receiving a growth-promoting implant (Deutscher et al., 1986; Hancock et al., 1994), as well as a reduction in pregnancy rates for heifers receiving an implant (Staigmiller et al., 1983). Furthermore, previous research has failed to elucidate the impact of growth-promoting implants given at either branding or weaning on ovarian measurements and function.

Thus, it is hypothesized that heifers receiving a growth-promoting implant at either branding or weaning will have increased weight gains, while maintaining similar overall reproductive performance and ovarian function. The objective of this study was to determine the effects of growth-promoting implants on growth, reproductive efficiency, and ovarian development.

MATERIALS AND METHODS

All animal procedures and facilities were approved by the New Mexico State University Institutional Animal Care and Use Committee.

Animals, Diets, and Treatments

Spring-born Angus × Hereford heifers (N = 170) were used in a completely randomized design to compare utilization of growth-promoting implants on developing heifers grazing dormant native range. The study was conducted over a 2-yr period at the New Mexico State University Corona Range and Livestock Research Center (CRLRC) located 13 km east of Corona, NM (34°15′36″N, 105°24′36″W). Heifers were assigned to one of three treatments at branding: 1) non-implanted controls (CON); 2) heifers receiving a growth-promoting implant (100-mg progesterone + 10-mg estradiol; Synovex C; Zoetis Animal Health, Florham Park, NJ) at approximately 3 mo of age (branding implant [BIMP]); or 3) heifers receiving a growth-promoting implant (100-mg progesterone + 10-mg estradiol; Synovex C) at approximately 8

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mo of age or (weaning implant [WIMP]). Heifers were offered supplements as needed after weaning to provide a minimum average daily gain (ADG) of 0.09 kg/d. Rangeland pasture vegetation is described by Forbes and Allred (2001). Heifers had ad libitum access to water and a loose salt–mineral mix formulated to complement available forage. The loose-salt mineral was composed of 10% Ca, 7% P, 2% Mg, 0.5% K, 2,500 ppm Cu, 5,000 ppm Zn, 2,500 ppm Mn, 75 ppm I, 15 ppm Se, and 246 KIU/kg vitamin A (Hi-Pro Feeds, Friona, TX).

Breeding

Estrus was synchronized using the 7-d CIDR-PG protocol. Heifers received a CIDR (controlled internal drug release device; Eazi-Breed, Zoetis Animal Health) insert for 7 d after which the CIDR was removed and all heifers received a single 5-mL i.m. injection of prostaglandin F2α (PGF2α) (Lutalyse, Zoetis Animal Health). At time of CIDR removal an estrus detection aid (Estrotect; MAI Animal Health, Elmwood, WI) was applied. Upon removal of CIDR insert, heifers were placed in a common pasture and estrus detection performed for 5 d following PGF2α administration. Heifers were subjected to artificial insemination (AI) approximately 12 h after observed standing estrus. Approximately 10 d following the last day of AI, heifers were exposed to bulls for approximately 45 d. First service conception rates were determined 30 d after AI and overall pregnancy rates were determined at a minimum of 30 d after bull removal by analyzing whole blood for pregnancy specific protein-B (Biopryn; Biotracking Inc., Moscow, ID).

Morphometric Analysis of Ovaries

At breeding a subset of heifers (n = 16) were unilaterally ovariectomized in yr 2. Estrus synchronization occurred using at 7-d CIDR protocol to induce a follicular phase and ovulation for timed AI. Thirty-six hours after CIDR removal, unilateral ovariectomy occurred via right flank laparotomy (Youngquist et al., 1995). Ovaries were weighed, and height and length recorded immediately upon collection. The height and length of the largest follicle were recorded as were the numbers of small (1 to 5 mm) and medium (5.1 to 10 mm) follicles. A representative section of ovarian cortex (1.5-mm thick) from the center of the ovary was fixed in 4% paraformaldehyde overnight. The subsequent day, ovarian tissue was postfixed in ethanol. Follicular fluid progesterone and estradiol concentrations were quantified by radioimmunoassay using components of a solid phase kit (MP Biomedicals, LLC, Santa Ana, CA) as reported by Schneider and Hallford (1996). Follicular fluid was diluted 1:100 for both estradiol and progesterone. Intra-assay coefficients of variation were 4.5% for progesterone and 13.4% for estradiol.

Statistical Analysis

Data were analyzed using the MIXED and GLIMMIX procedures of SAS (SAS Institute Inc., Cary, NC). The model included implant treatment, year, and the interaction of implant treatment × year. Pregnancy rates were analyzed using the GLIMMIX procedure of SAS with a binomial distribution and a logit link to examine the fixed effect of implant treatment. The influence of implant treatment on microscopic follicle number was analyzed using the GLIMMIX procedure of SAS with a logit link and a Poisson distribution.

RESULTS AND DISCUSSION

Growth Performance

Heifer BW and ADG for the development period are reported in Table 1. Heifers receiving growth-promoting implants at 3 mo of age were heavier (P = 0.01) at weaning compared to WIMP and CON heifers. The payout period of Synovex C is 100 to 140 d and is designed to increase growth rate in suckling calves under 182 kg, therefore, increased BW at weaning was expected. Greater yearling BW (P = 0.02) was observed in BIMP heifers compared to heifers receiving a growth-promoting implant at weaning. Furthermore, there was a tendency (P = 0.06) for BIMP heifers to maintain an increased BW at the start of the breeding season compared to WIMP heifers. Hancock et al. (1994) reported greater weaning BW in heifers receiving a growth-promoting implant at 2 mo of age, this BW advantage was maintained to 1 mo of age. Similar to results in the current study, heifers implanted at 6 mo of age exhibited no increase in growth or weight gain (Hancock et al., 1994). ADG from weaning to yearling was similar (P = 0.38) among treatments. Moreover, ADG did not differ (P = 0.09) from yearling to the start of the breeding season. Overall ADG from weaning to the start of the breeding season was greater (P = 0.04) for WIMP heifers compared to BIMP heifers, with CON heifers similar to both BIMP and WIMP

Table 1. Effect of growth-promoting implants administered at either branding or weaning on heifer body weight, average daily gain, and reproductive performance

Item	CON[1]	BIMP[2]	WIMP[3]	SEM	*P* value
No. of Heifers	57	61	52		
Body weight, kg					
Weaning weight	223[b]	235[a]	217[b]	4.37	0.01
Yearling weight	218[ab]	228[a]	212[b]	4.22	0.02
Breeding weight	241[ab]	248[a]	235[b]	4.04	0.06
Average daily gain, kg/d					
Weaning to yearling	−0.05	−0.07	−0.05	0.01	0.38
Yearling to breeding	0.28	0.26	0.31	0.02	0.09
Total[4]	0.08[ab]	0.06[a]	0.09[b]	0.008	0.04
Estrus response, %	49	55	72	7.05	0.08
First service conception rate, %	75	65	53	10.56	0.28
Overall pregnancy rate, %	85	81	84	5.86	0.86

[a,b]Means within a row without a common superscript differ.

[1]CON = heifers received no growth-promoting implant.

[2]BIMP = heifers received a single Synovex C implant at 3 mo of age.

[3]WIMP = heifers received a single Synovex C implant at 8 mo of age.

[4]Heifer average daily gain from weaning to the start of the breeding season.

heifers. Synovex C is intended to increase weight gain in suckling calves up to 182 kg, therefore, the lack of increased growth performance reported in WIMP heifers may be partially attributed to the lower dose of hormones in Synovex C compared to growth-promoting implants intended for older heifers. Furthermore, heifers were grazing low-quality dormant forage following weaning, consequently inadequate nutrient availability may not have allowed for full effectiveness of the Synovex C implant. Paisley et al. (1999) conducted research in steers receiving a growth-promoting implant during the stocker phase while grazing low-quality forage receiving protein supplementation. Implants improved winter gains compared to non-implanted controls with daily gains in all steers below 0.47 kg/d in period 1 and below 0.22 kg/d in period 2 (Paisley et al., 1999). These results suggest that with adequate nutrient availability implants may still improve gains while animals are grazing low-quality forage. In the current study, however, heifers in all treatments had a negative ADG from weaning to yearling, indicating inadequate nutrient availability.

Reproductive Performance

Heifer estrus response, first service conception rates, and overall pregnancy rates are reported in Table 1. There was no difference ($P = 0.08$) in estrus response between non-treated control and heifers receiving a growth-promoting implant. Heifers receiving a Synovex C implant at branding or weaning, as well as non-implanted control heifers had similar ($P = 0.12$) first service conception rates. Previous research has reported no differences in first service conception rate and average conception date among heifers implanted at 2 or 6 mo of age with a Synovex C implant compared to non-implanted controls (Hancock et al., 1994). No significant differences were found among treatments ($P = 0.30$) in overall pregnancy rates among treatments. Hancock et al. (1994) reported implanting heifers with Synovex C at 2 or 6 mo of age did not differ in the percentage of heifers pregnant in the first 21 d or overall pregnancy rate in yr 1 but decreased pregnancy rates in heifers implanted at 6 mo of age in yr 2.

Heifer antral follicle counts, reproductive tract scores, and uterine horn diameters are reported in Table 2. Antral follicle counts did not differ ($P = 0.45$) among CON, BIMP, and WIMP heifers. Antral follicle count is a prediction tool for measuring fertility and the ovarian reserve. To the best of our knowledge, previous literature has not investigated the influence of the utilization of growth-promoting implants administered during either the suckling phase or at weaning on antral follicle counts in beef heifers. In addition, uterine horn diameter did not differ ($P = 0.38$) between treatments, suggesting that utilization of a single Synovex C implant administered at either 3 or 8 mo of age did not alter uterine size or maturity. Likewise, no differences were observed between treatment for reproductive tract scores ($P = 0.44$). Reproductive tract score is an indicator of

Table 2. Effect of growth-promoting implants administered during the suckling phase on heifer antral follicle count, reproductive tract score, and uterine horn diameter in yr 2

Item	CON[1]	BIMP[2]	WIMP[3]	SEM	*P* value
No. of Heifers	34	31	30		
Antral follicle count	22.9	24.4	25.4	1.40	0.45
Uterine horn diameter, mm	8.76	8.36	8.27	0.29	0.38
Reproductive tract score[4]	4.6	4.5	4.4	0.14	0.44

[1]CON = heifers received no growth-promoting implant.

[2]BIMP = heifers received a single Synovex C implant at 3 mo of age.

[3]WIMP = heifers received a single Synovex C implant at 8 mo of age.

[4]Reproductive tract score (Martin et al., 1992).

Table 3. Effect of growth-promoting implants administered at either branding or weaning on heifer ovarian measurements and follicular fluid hormone concentrations in yr 2

Item	CON[1]	BIMP[2]	WIMP[3]	SEM	*P* value
No. of Heifers	7	5	4		
Ovarian weight, g	4.63	4.13	3.27	0.72	0.35
Ovarian area, mm^2	600.2	648.9	438.1	67.4	0.09
Surface follicle counts	35.9	32.8	23.7	6.67	0.34
Preovulatory follicle diameter, mm	11.4	13.6	11.1	1.06	0.17
Estradiol, ng/mL	319.6	145.4	141.1	145.8	0.52
Progesterone, ng/mL	55.1	46.6	51.4	10.8	0.82
Estradiol:progesterone	5.92	2.98	2.97	2.75	0.60

[1]CON = heifers received no growth-promoting implant.

[2]BIMP = heifers received a single Synovex C implant at 3 mo of age.

[3]WIMP = heifers received a single Synovex C implant at 8 mo of age.

reproductive maturity and an estimate of pubertal status. The average reproductive tract score of all treatments was greater than 4.4, indicating similar pubertal status regardless of treatment. Similar reproductive tract scores and antral follicle counts are an indicator that implants did not deleteriously affect reproductive development prior to the onset of the breeding season.

Ovarian Measurements

Ovarian measurements and follicular fluid hormone concentrations are reported in Table 3. Ovarian weight did not differ (P = 0.35) between CON, BIMP, and WIMP heifers. Ovarian area was similar (P = 0.09) among treatments. Furthermore, no significant differences were found (P = 0.34) among treatments in overall surface counts of medium and small follicle. In addition, the diameter of the preovulatory follicle was similar (P = 0.17) regardless of implant treatment. Previous research has failed to explore the influence on administration of growth-promoting implants in heifers on ovarian function and development. Estradiol concentration in the follicular fluid can be an indicator of the ability of the oocyte to become successfully fertilized. Oocytes from follicles with greater concentrations of estradiol were more likely to develop to the blastocysts following in vitro fertilization (reviewed by Pohler et al., 2012). No differences (P > 0.52) were found in concentrations of progesterone and estradiol in the follicular fluid of the dominant follicle among implanted and non-implanted heifers. In addition, the ratio of estradiol to progesterone in the follicular fluid of dominant follicles was similar (P = 0.60) between BIMP, CON, and WIMP heifers. These data indicate dominant follicles were estrogen active, suggesting oocytes collected from both heifers in all treatments had the potential to become successfully fertilized.

IMPLICATIONS

Utilization of growth-promoting implants in beef heifers administered at 3 mo of age can increase weaning weights without negatively affecting reproductive performance of heifers intended to be retained as replacements. Results indicate that Synovex C implants may potentially be integrated into cow/calf production systems without causing significant deleterious effects on heifer fertility. Furthermore, similar pregnancy rates, as well as comparable ovarian measurements and surface follicle counts provide further evidence that growth-promoting implants may not be detrimental to reproductive performance. The BW advantage at weaning in heifers administered a growth-promoting implant at 3 mo of age (branding) combined with similarities in reproductive performance would suggest, strategic utilization of growth-promoting implants may be a viable management strategy for producers.

Conflict of interest statement. None declared.

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