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EFFECTS OF ADMINISTERING PROGESTERONE OR PROGESTERONE AND GnRH ON AGE AT PUBERTY IN CROSSBRED BEEF HEIFERS

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Summary

A study using 143 replacement beef heifers was conducted over a 3-year period to determine the effects that progesterone or progesterone and gonadotropin releasing hormone (GnRH) would have on age at puberty in beef heifers. Progesterone treated heifers were 21.8 and 38.9 days younger ($P<.05$) at puberty than control heifers in the first 2 years of the study, while progesterone plus GnRH treated heifers were 35.4 days ($P<.01$) and 31.2 days ($P<.05$) younger than controls. No difference ($P>.05$) in age at puberty was detected between groups in the third year. While progesterone and progesterone plus GnRH treated heifers had a higher conception rate ($P<.01$) to AI than controls in the first year of the study, calving records showed they experienced a higher rate of embryonic loss. However, calving rate still remained higher than in the control group. These differences were not observed in the second year and calving data for the final year of the study is currently not available.

Key Words: Beef Heifers, Puberty, Progesterone, GnRH, Fertility

Introduction

Replacement beef heifers must calve early in the calving season at 2 years of age to achieve maximum lifetime calf productivity. This implies that yearling heifers must be bred successfully in the early portion of the breeding season. Under typical production conditions, some replacement heifers will not reach puberty until after the onset of the breeding season, and a larger proportion will be in their first estrous cycle at first service. This situation is undesirable since improved conception rates have been realized when heifers are bred on their third or fourth estrus in comparison to the first. Therefore, methods which cause puberty to occur in heifers at an earlier age may be useful and economically advantageous to the producer, since induction of an earlier puberty will in turn cause more heifers to be cycling before the beginning of the breeding season. Several previous studies which have utilized hormone administration to prepuberal heifers to induce puberty at an earlier age have met with varying levels of success.

The following study was conducted to determine the effects that administration of progesterone, alone or in combination with gonadotropin releasing hormone (GnRH), would have on age at puberty and the subsequent breeding success in crossbred beef heifers.

Materials and Methods

The study was conducted over a 3-year period on the campus of South Dakota State University. One hundred forty-three crossbred beef heifers raised at the Antelope Range Livestock Station in northwestern South Dakota were randomly assigned to one of three treatments in late winter following weaning.

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Table 1 lists the number of days before the breeding season when treatments were applied and the average age and weight of the heifers at time of treatment according to year. Heifers assigned to treatment 1 were designated as controls and did not receive any hormone treatment. Heifers assigned to treatment 2 were given a Synchromate-B[4] norgestomet implant for 9 days. Heifers assigned to treatment 3 in the first 2 years of the study also received a norgestomet implant for 9 days. Upon removal of the norgestomet implant, a GnRH[5] implant was given for the following 9 days. In the last year of the study, heifers in treatment 3 were given a 2 mL injection containing 1000 μg GnRH subcutaneously following the norgestomet implant removal.

Table 1. Age and weight of heifers at time of hormone treatment

Year	Days before breeding season	Age, days	Wt, lb
1991	97	319	642
1992	120	291	604
1993	109	308	619

Blood samples were collected from all heifers via jugular venipuncture on a weekly basis beginning on the day of progesterone implantation. Upon centrifugation, blood sera was collected and progesterone concentration from each sample was determined with a one-step radioimmunoassay procedure. Samples containing a progesterone concentration exceeding 1 ng/mL were indicative of a functional corpus luteum at the time of collection. When a weekly sampling procedure is used, the exact sequence of high and low progesterone levels will vary from heifer to heifer since the normal luteal phase in the bovine lasts from 10 to 14 days. A heifer was considered to be cycling when her blood serum progesterone levels were over 1 ng/mL for 1 to 2 bleedings, followed by a decrease during the next 1 to 2 bleedings, which was succeeded by a similar fluctuation in progesterone over the next 3 to 4 weeks. Date of puberty was estimated to be 5 days before the first elevated progesterone concentration appeared. All heifers were weighed on a periodical basis and weight at puberty was calculated for each heifer through extrapolation of the two weighings most closely associated with the date of puberty.

In early May a 45-day breeding season was begun for each year. A 21-day artificial insemination period was followed by placement of a cleanup bull with the heifers until termination of the breeding season. Blood samples were collected weekly for four weeks from those heifers detected in estrus to monitor progesterone concentrations. Heifers displaying elevated levels of progesterone for 3 or more consecutive bleedings were considered to be pregnant. Pregnancy rates to the overall breeding season were determined via rectal palpation 60 days after the end of the breeding season. Pregnancy to AI was also determined through examination of the subsequent calving dates in the first two years of the study. Neither palpation or calving data for the 1992 born replacement heifers was available at the time of publication. Conception data derived from the progesterone assays were compared with the calving data in the first 2 years of the study to determine early embryonic loss.

Ten heifers had progesterone concentrations over 1 ng/mL on the first bleeding and were removed from the study. One heifer included in the 1993 study group never cycled and was also removed. The remaining 132 heifers cycled at least once during the period in which they were under study and were included in the analysis. Statistical analyses of age and weight at puberty

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by treatment were performed using the GLM procedures of SAS. Chi-square analysis was performed for the pregnancy data.

Results and Discussion

Age and weight at puberty for each treatment group within year is reported in Table 2. Progesterone treated heifers were 21.8 days and 38.9 days younger ($P<.05$) at puberty than control heifers in 1991 and 1992, respectively, although there was no difference in age in 1993. Progesterone plus GnRH treated heifers were 35.4 days younger in 1991 ($P<.01$) and 31.2 days younger in 1992 ($P<.05$) than control heifers. Age at puberty for these two groups in 1993 was not different. The lack of difference between treatment groups for age at puberty in 1993 may be partially attributed to the small number of heifers used in that year ($n = 28$).

There was no significant weight difference at puberty between progesterone treated and control heifers in 1991 and 1993. Progesterone treated heifers weighed 71.1 lb less at puberty than nontreated heifers in 1992 ($P<.05$). Progesterone plus GnRH treated heifers weighed 49.8 lb less at puberty than control heifers in 1991 ($P<.05$), but no differences were observed in 1992 and 1993. Since hormone treated heifers weighed less at puberty than controls, this suggests that the hormones used in the treatments accelerated physiological changes associated with puberty rather than causing puberty to occur because of increased body weights.

Table 2. Effects of progesterone and progesterone plus GnRH on age and weight at puberty

	Treatment		
	Control	Progesterone	Progesterone plus GnRH
1991			
Number of heifers	20	22	23
Age at puberty, days[a]	372.1 (6.8)[c]	350.3 (6.5)[b]	336.7 (6.4)[b]
Wt at puberty, lb[a]	703.8 (16.5)[b]	661.4 (15.7)[bc]	654.0 (15.4)[c]
1992			
Number of heifers	13	13	13
Age at puberty, days	351.9 (10.3)[c]	313.0 (10.3)[b]	320.7 (10.3)[b]
Wt at puberty, lb	711.5 (20.0)[c]	640.4 (20.0)[b]	665.2 (20.0)[bc]
1993			
Number of heifers	9	9	10
Age at puberty, days	360.7 (12.2)	352.9 (12.2)	352.0 (11.5)
Wt at puberty, lb	701.6 (26.9)	685.1 (26.9)	697.1 (25.5)

[a]Least squares means followed by standard errors.
[b,c]Means within a row lacking a common superscript letter differ ($P<.05$).

Table 3 lists the pregnancy rate to AI (according to progesterone concentrations), pregnancy to the overall breeding season, calving rate to AI, and overall calving rate. Pregnancy to AI according to progesterone differed among treatment groups in 1991 at the .01 level, although calving rate to AI for these heifers differed among treatment groups at the .05 level. No other differences in any year were detected. Although hormone treated heifers in 1991 had higher pregnancy rates to AI than controls, the reduced difference between groups at calving suggests that hormone treated heifers also had a higher rate of embryonic loss. This trend was not apparent in 1992.

The results of this study suggest that administration of progesterone or progesterone and GnRH to prepuberal heifers will cause puberty to occur at an earlier age. While heifers given progesterone plus GnRH were younger at puberty than their contemporary controls in 1991 and 1992, no such difference was noted in 1993. This may be explained by the mechanism of GnRH administration. In the first 2 years of the study a GnRH implant was given, whereas the heifers in 1993 received a GnRH injection. It is possible that the injection did not provide as prolonged a release as the implant, although it is difficult to determine if the progesterone plus GnRH treatment was ineffective for this reason. Since heifers treated with progesterone only did not reach puberty at an earlier age in that year either, the small number of heifers used in that year made it difficult to statistically determine any differences between treatments. While administering the hormone treatments immediately before the breeding season may not show a difference in age at puberty between treated heifers and controls, several reports have cited heifers must be of sufficient age and size to be able to respond to the hormone therapy as well. Our results suggest that administration of progesterone or progesterone plus GnRH are both effective in induction of puberty when given to heifers 97 to 120 days before the breeding season.

Table 3. Pregnancy and calving rates to AI and overall breeding season

Year/treatment	No. heifers	Pregnancy to AI[a]	Pregnancy to season[a]	Calving to AI[a]	Calving to season[a]
1991					
Control	20	8 (40.0)[c]	18 (90.0)	6 (30.0)[e]	18 (90.0)
Progesterone	22	15 (68.2)[b]	19 (86.4)	11 (50.0)[d]	19 (86.4)
Progesterone plus GnRH	23	19 (82.6)[b]	22 (95.7)	13 (56.5)[d]	21 (91.3)
1992					
Control	13	8 (61.5)	12 (92.3)	6 (46.2)	11 (84.6)
Progesterone	13	11 (84.6)	13 (100.0)	9 (69.2)	12 (92.3)
Progesterone plus GnRH	13	8 (61.5)	12 (92.3)	5 (38.5)	10 (76.9)
1993					
Control	9	6 (66.7)	NA[f]	NA	NA
Progesterone	9	9 (100.0)	NA	NA	NA
Progesterone plus GnRH	10	7 (70.0)	NA	NA	NA

[a]Actual values followed by percentage.
[b,c]Means within a column within year lacking a common superscript letter differ (P<.01).
[d,e]Means within a column within year lacking a common superscript letter differ (P<.05).
[f]Data not available at this time.