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A Novel Estrous Synchronization Program for Beef Cattle Using Melengestrol Acetate

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Estrous cycles can be synchronized among anestrous and estrual beef females by feeding melengestrol acetate for 18 days and injecting progesterone and estradiol 7 days before end of MGA feeding.

Summary

Estrous synchronization rate and conception and pregnancy rates to AI were evaluated following three estrous synchronization protocols for beef cattle. During 1995 and 1996, heifers and cows (n = 379) received either: 1) melengestrol acetate (MGA) for 18 days plus an injection of progesterone and estradiol in oil 7 days before end of treatment; 2) MGA for 17 days; or 3) two injections of $PGF_{2\alpha}$ 10 days apart. The greatest pregnancy rates (number conceived/number treated) among both anestrous and estrual females were achieved following treatment with MGA and an injection of progesterone and estradiol.

Introduction

Estrous synchronization programs in beef herds can condense labor during breeding and calving seasons as well as produce calves more uniform in weight. Programs incorporating progestins such as norgestomet, MGA and (or) progesterone can also induce estrous cycles in anestrous females. Treatment with commercially used doses of a progestin in the absence of corpora lutea results in development of persistent ovarian follicles. While reduced fertility is associated with ovulation of persistent ovarian follicles, fertility can be improved with short-term progesterone treatment to induce regression of persistent ovarian follicles.

Development of a relatively inexpensive estrous synchronization program limiting animal handling without compromising pregnancy rates (number females pregnant/number females treated) would benefit the beef industry. We hypothesized that estrous synchronization of beef females using MGA and an injection of progesterone and estradiol would maximize pregnancy rates as compared with use of MGA alone or two injections of $PGF_{2\alpha}$.

Procedure

Angus x Gelbvieh heifers (n = 52) and mature composite (MARC III; n=288) and Angus x Gelbvieh cows (n = 39) from the beef physiology herd were used during two years (1995 and 1996). Females were blocked by breed and were stratified by calving date and assigned to receive one of the following: 1) MGA (.5 mg/hd/day) for 18 days plus an injection of 200 mg progesterone and 1 mg estradiol in sesame oil on day 11 (MGA+P_4; day 0 = first day of MGA feeding); 2) MGA for 18 days plus an injection of sesame oil on day 11 (MGA); or 3) two injections of $PGF_{2a\alpha}$ (25 mg; Lutalyse® Sterile Solution, Upjohn, Kalamazoo, MI) on day 7 and 17 (PG).

During the experiment, females were maintained in bromegrass pastures. During 1995, 2 lb per animal of forage-based pellets containing MGA were fed with either range cubes or corn (1.5 to 2 lb/hd/day) for females in the MGA or MGA+P_4 treatment groups, while females in the PG treatment group received range cubes (3.5 to 4 lb/hd/day). Because feed consumption for females treated with MGA was inconsistent throughout the treatment period, mechanisms such as feeding molasses and keeping cattle off pasture overnight were used to help maintain MGA consumption.

To alleviate variation in MGA consumption, changes were made in nutritional management during the second year. Salt was restricted from all cattle 18 days before MGA feeding. Soybean hull pellets (2 lb/hd/day) were fed 13 days before MGA feeding to acclimate cattle to bunks. Three days before MGA feeding, soybean hull pellets containing salt (.13 lb/lb feed) were provided to all cows (2 lb/hd/day). Soybean hull pellets (2 lb/hd/day) containing salt and MGA (.25 mg/lb) were fed during the treatment period to females in the MGA and MGA+P_4 treatment groups, while females in the PG group continued to receive pellets (2 lb/day) consisting of only soybean hulls and salt. Restriction of salt intake was implemented to stimulate a salt consumption desire. Including salt in the feed just prior and during MGA feeding was expected to decrease consumption variation of MGA as well as maintain MGA consumption over the 18-day treatment period. From end of treatment until the end of estrous detection and AI, all females were fed

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pellets containing soybean hulls and salt. During 1995 and 1996, MGA failed to suppress ovulation during treatment in 20 of 132 (15.2%) and 13 of 118 (11%) of females treated with MGA or MGA+P_4. In 1996, body condition scores (1 = thin, 9 = fat) were assessed for all animals on day 0 and day 17 of the experiment.

Blood samples were collected on day 0 (initiation of MGA feeding), 7 and 17 of the experiment to characterize progesterone concentrations and determine estrual status (exhibiting estrous cycles or anestrus). Blood samples collected on day 0, 7, 9, 11, 13, 15 and 17 were used to determine concentration of estradiol in circulation.

Females with concentrations of progesterone ≥ 1 ng/ml of serum on day 0, 7 or 17 were considered to have luteal function and were categorized as estrual. All other females were categorized as anestrus.

Females were observed for behavioral estrus every 6 hours from day 17 (last day of MGA feeding or 2nd injection of $PGF_{2\alpha}$) until day 24 with the aid of K-Mar devices and epididymal ligated bulls. Females exhibiting signs of estrus were bred by AI 6 to 12 hours following detection. Uterine ultrasonography was performed 35 to 40 days following AI to determine conception rate.

Results and Discussion

Concentration of Estradiol

Concentration of estradiol was elevated during or increased near the end of treatment among both anestrous and estrual females treated with only MGA (Figures 1 through 4). Among estrual females, corpus luteum regression would have occurred at random during the treatment period. Treatment with MGA in the absence of a corpus luteum allows for increased pulse frequency of LH, resulting in development of persistent ovarian follicles and associated elevated concentrations of estradiol. Random initiation of development of persistent ovarian follicles corresponding with onset of luteal regression likely occurred in the present study. As indicated by the elevated concentration of estradiol in circulation on day 17 of the experiment, a majority of estrual females likely had persistent follicles present in their ovaries at cessation of MGA feeding.

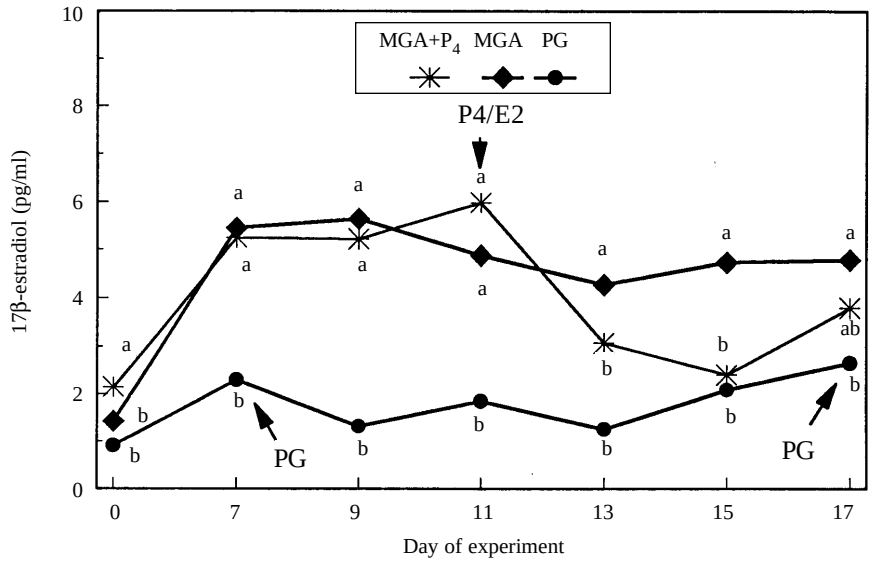

Figure 1. Concentration of estradiol among anestrous composite females during treatments to synchronize estrous cycles. Uncommon superscript letters within day indicate differences across treatment groups (^{a,b,c} P < .05).

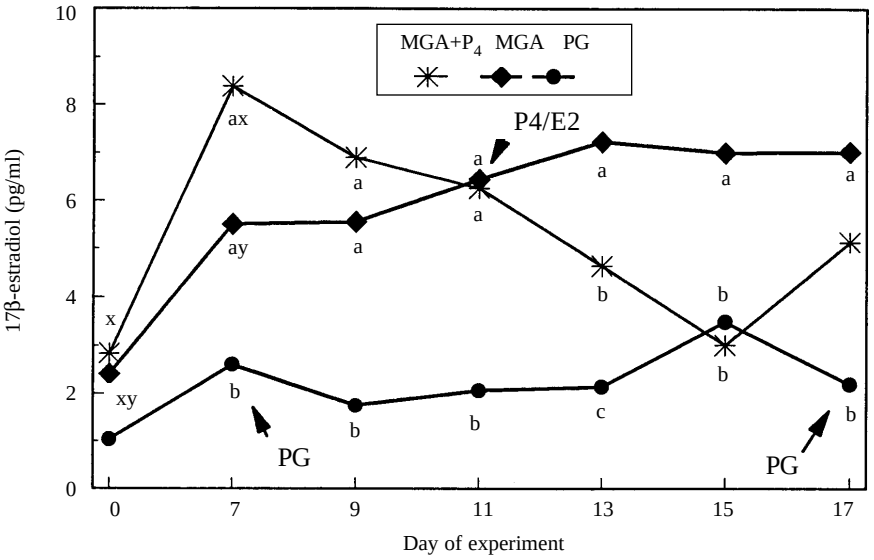

Figure 2. Concentration of estradiol among anestrous Angus x Gelbvieh females during treatments to synchronize estrous cycles. Uncommon superscript letters within day indicate differences across treatment groups (^{a,b,c} P < .05;^{x,y} P < .10).

Generally, concentrations of estradiol were greater during the treatment period among anestrous females fed MGA as compared with the PG group. This indicates treatment of anestrous females with a progestin such as MGA is able to elicit changes, presumably in secretion of LH, and subsequently in ovarian follicle development and secretion of estradiol.

Among anestrous females of both breeds and estrual composite females in the MGA+P_4 group, concentrations of estradiol decreased from day 11 to day 13. Administration of progesterone and estradiol in oil to females of this group occurred on day 11 and was expected to induce regression of persistent ovarian follicles. The sharp decline in concentration of estradiol among

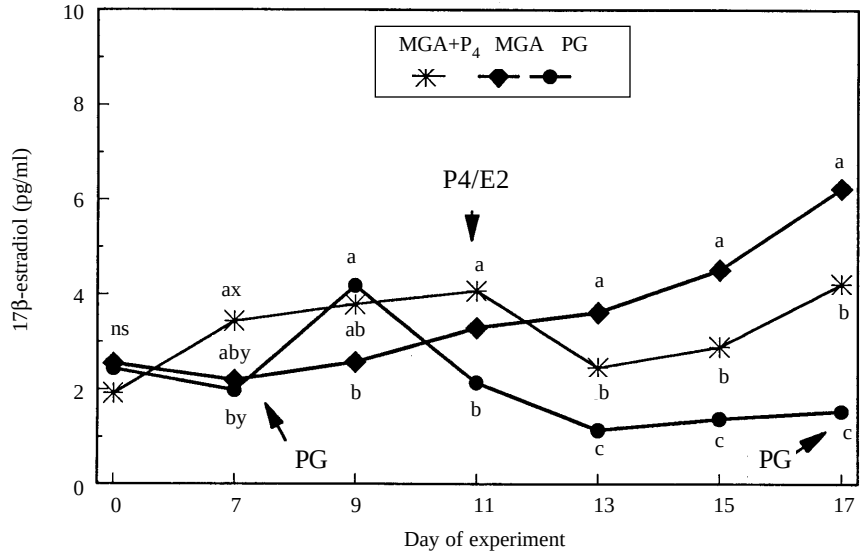

Figure 3. Concentration of estradiol among estrual composite females during treatments to synchronize estrous cycles. Uncommon superscript letters within day indicate differences across treatment groups (^{a,b,c} P < .05; ^{x,y} P < .10).

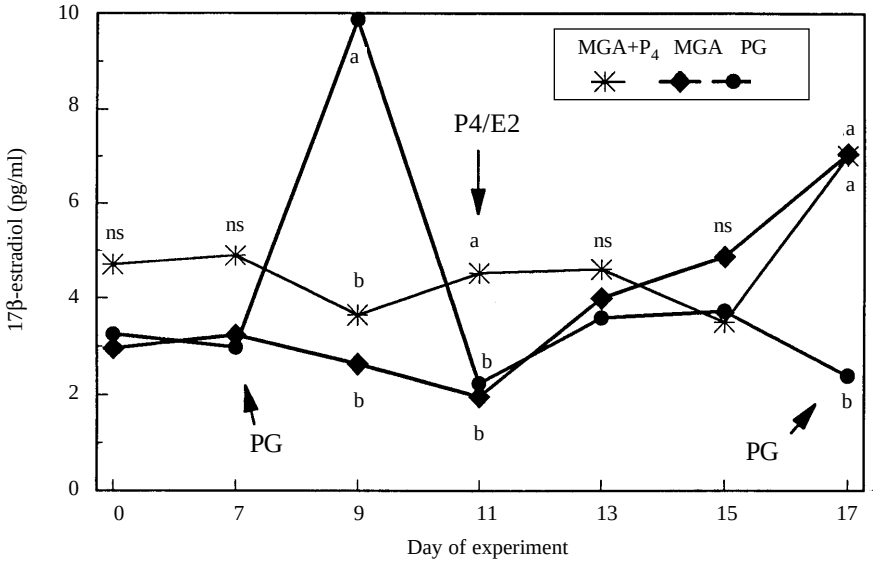

Figure 4. Concentration of estradiol among estrual Angus x Gelbvieh females during treatments to synchronize estrous cycles. Uncommon superscript letters within day indicate differences across treatment groups (^{a,b,c} P < .05).

anestrous and estrual females of composite breeding in the MGA+P_4 group indicates that regression of persistent ovarian follicles was achieved. It is unclear why estrual females of Angus x Gelbvieh breeding did not have a similar estradiol concentration decline following the injection of progesterone and estradiol. Perhaps a significant portion of these females were in the luteal phase of their estrous cycle at the time of the injection (on day 11) such that no persistent ovarian follicles were present to regress.

Concentration of estradiol increased on day 9 among estrual females in the PG group. The especially large increase in concentration of estradiol on day 9 among estrual Angus x Gelbvieh heifers was apparent among most females treated with $PGF_{2\alpha}$ on day 7. Corpus luteum regression, and initiation of the follicular phase of the estrous cycle, would have occurred among females treated with $PGF_{2\alpha}$ that had a corpus luteum capable of responding to $PGF_{2\alpha}$ on day 7. The increase in estradiol concentration on day 9 would coincide with development of the ovulatory follicle. Absence of an estradiol increase among anestrous females on day 9 confirms these females were anestrous during the treatment period.

Time to estrus

Treatment and estrual status interacted (P = .02) to affect time to estrus. Among anestrous females, interval from treatment cessation to onset of estrus was similar among females in the PG as compared with the MGA+P_4 group (Table 1). Compared to females treated with MGA, interval from treatment cessation to onset of estrus was shorter (P = .006) among females treated with MGA+P_4 and tended (P = .09) to be shorter among females treated with PG. Among estrual females, interval from treatment cessation to onset of estrus was similar among females in the MGA and MGA+P_4 groups and MGA and PG groups, but was shorter (P = .05) in females treated with PG as compared with those treated with MGA+P_4.

We expected treatment with MGA alone would result in the shortest interval to estrus onset due to the advanced stage of ovarian follicle development at the time of treatment withdrawal. Perhaps ovarian follicles of some animals were not at an advanced stage of development at treatment withdrawal, but rather had undergone natural atresia before cessation of MGA feeding.

Estrous synchrony rate

Treatment and estrual status interacted (P < .001) to affect estrous synchrony rate (number in estrus/number in group; Table 1). Among anestrus females, a greater (P < .001) percentage of females in the MGA and MGA+P_4 groups exhibited estrus following treatment compared with females in the PG group. There tended to be a greater (P = .10) percentage of anestrous females in the MGA+P_4 group exhibiting estrus following treatment compared with the MGA group. Among estrual females, a greater percentage of females in the PG

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Table 1. Estrous synchrony rates, conception and pregnancy rates to AI and time to behavioral estrus of females treated with MGA, MGA+P_4, or PG.

	Treatment		
Item	MGA	MGA+P_4	PG
Time to estrus, hours ± SEM[a]			
Anestrus	98.8 ± 5.5[x]	76.7 ± 5.7[y]	76.0 ±12.4[y]
Estrual	75.7 ± 6.2[xy]	79.8 ± 4.4[x]	66.7 ± 5.2[y]
Estrous synchrony rate, %[a]			
Anestrus[c]	66.1[x]	81.4[y]	28.0[z]
Estrual[d]	76.6[x]	89.9[y]	92.3[y]
Conception rate, %	50.0[x]	62.7[xy]	67.4[y]
Pregnancy rate, %[b]			
Anestrus	33.9[x]	45.8[x]	16.0[y]
Estrual, 1995	44.2[x]	51.2[xy]	64.7[y]
Estrual, 1996	23.8[x]	76.9[y]	63.0[y]

[a]There was a treatment x estrual status interaction ($P < .001$), therefore animals that were estrual and anestrus were analyzed separately.
[b]There was a treatment x estrual status interaction ($P = .003$), therefore animals that were estrual and anestrus were analyzed separately. Within estrual animals there was a treatment x year interaction (P = .06), therefore estrual animals within each year (1995 and 1996) were analyzed separately.
[x, y, z]Means within a row lacking a common superscript differ ($P \leq .10$).

($P = .02$) and MGA+P_4 ($P = .07$) groups exhibited estrus following treatment compared with the MGA group; however, estrous synchrony rates were similar among females in the PG and MGA+P_4 groups. Body condition score, age, number of days postpartum and year neither affected nor interacted with treatment to alter estrous synchrony rate.

Estrous synchronization rates are typically improved with progestin-based estrous synchrony programs because of the progestin's ability to induce estrous cycles in anestrous females. In this study, 23% of heifers and 48% of cows were determined to be anestrus prior to end of treatment. A greater percentage of anestrous females in the MGA (66%) and MGA+P_4 (81%) groups were induced to exhibit estrus following treatment compared with the PG group (28%). Among both anestrous and estrual females, a greater percentage of females in the MGA+P_4 group exhibited estrus following treatment compared with MGA treatment alone. It is unclear why additional treatment with progesterone and estradiol improved estrous synchrony rate.

Inconsistent consumption of MGA, especially during 1995, likely resulted in lower estrous synchronization rates among females in the MGA+P_4 and MGA groups. During 1995 and 1996, 15 and 11 %, respectively, of females fed MGA appeared to have ovulated during MGA feeding. During 1996, we attempted to alleviate problems regarding consumption of MGA by strategic restriction and replacement of salt in the rations. This change resulted in a 4 % decrease in females ovulating during MGA feeding. Females in this study were maintained on pasture during the experiment and MGA feeding occurred in May, a time of maximal forage growth in both 1995 and 1996. As a result, cattle were more likely to graze and become satiated on forages, decreasing consumption of MGA. It is likely that in a drylot situation, estrous synchronization of beef females with MGA plus progesterone and estradiol would result in an improved estrous synchronization rate.

Conception rate

Conception rate (number conceived to AI/number AI'ed) did not differ among females in either the PG or MGA+P_4 groups, but was greater (P =.04) among females in the PG as compared with MGA group (Table 1).

Conception rate to AI was acceptable among females in the PG and MGA+P4 groups. Conception rate of females treated with MGA alone was greater than expected. Treatment with doses of commercially used progestins or low doses of progesterone in the absence of a corpus luteum results in development of persistent ovarian follicles. Perhaps during the long-term MGA feeding, some persistent ovarian follicles naturally regressed, allowing AI to coincide with ovulation of typically developing ovulatory follicles, improving conception rates. The elevated concentrations of estradiol among both anestrous and estrual composite and Angus x Gelbvieh females indicate large, persistent ovarian follicles were still present near the end of the treatment period.

Pregnancy rate

Treatment and estrual status interacted (P =.003) to affect pregnancy rate (number conceived to AI/number in group; Table 1). There was an effect ($P < .05$) of year on pregnancy rate among anestrous females where pregnancy rate did not differ among females in the MGA or MGA+P_4 groups, however, it was greater among females in the MGA ($P = .05$) and MGA+P_4 ($P < .01$) groups as compared with the PG group.

Among estrual females, treatment and year interacted (P =.06) to affect pregnancy rate. Among estrual females in 1995, pregnancy rate was greater ($P = .05$) among females treated with PG as compared with MGA, but did not differ from females treated with MGA+P_4. Among estrual females in 1996, pregnancy rate was greater ($P \leq .01$) among females treated with MGA+P_4 or PG as compared with MGA, but did not differ among females treated with MGA+P_4 and those treated with PG.

Pregnancy rates to AI among anestrous females were greater among females in the MGA or MGA+P_4 groups as compared with the PG group. Clearly, this advantage in pregnancy rate is due primarily to the improved rate of estrous synchrony achieved following treatment with MGA versus $PGF_{2\alpha}$. During 1996, consistent consumption of MGA was improved as compared to 1995. This is evidenced by more females consuming pellets for longer periods of time following feeding, but does not readily explain the 20 % decrease in pregnancy rate from 1995 to 1996 in estrual females in the MGA group as compared with the 25% in-

crease in pregnancy rate of estrual females in the MGA+P_4 group. It is important to recognize estrous synchronization of anestrous females with MGA plus progesterone and estradiol results in greater pregnancy rates as compared with PG, whereas among estrual females, greater pregnancy rates can be achieved following estrous synchronization with MGA plus progesterone and estradiol as compared with MGA alone. Ultimately, cow/calf producers are interested in maximizing herd pregnancy rates. Because most beef herds would likely consist of anestrous and estrual females, pregnancy rates to AI would be maximized most effectively by estrous synchronization with MGA plus progesterone and estradiol.

For beef producers to achieve maximal pregnancy rates, estrous synchronization rates, as well as conception rates, must be maximized. The present study provides evidence that long-term feeding of MGA, combined with an injection of progesterone and estradiol, is effective in synchronizing estrus and achieving acceptable conception rates to AI among both anestrous and estrual beef females.

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