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The Effect of Controlled Photoperiod, Ergocryptine, and/or Melatonin on Reproduction in the Anestrous Ewe

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THE EFFECT OF CONTROLLED PHOTOPERIOD, ERGOCRYPTINE, AND/OR MELATONIN ON REPRODUCTION IN THE ANESTROUS EWE

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Summary

The effect of decreased light and injections of ergocryptine (trial 1) or feeding of melatonin (trial 2) during the normal summer anestrous season of the ewe was studied. Decreased light (8 hr light:16 hr dark) and feeding of melatonin was effective in increasing the number of ewes cycling and conceiving. Decreased lighting also increased the total weight of all lambs born per ewe lambing compared to ewes in natural daylight during summer months. Ergocryptine appeared to have no effect on the ewe other than depressed prolactin levels.

(Key Words: Sheep, Summer Anestrus, Photoperiod, Melatonin, Ergocryptine).

Introduction

Seasonal breeding in ewes limits productivity and causes an unsteady supply of lambs to the market place. A successful and practical method of causing a continuous breeding season in ewes is needed to stabilize lamb supplies, farm labor and utilization of facilities. Causing ewes to exhibit fertile cycles during the normal summer anestrous period would be a means to extend the lambing season. In an effort to do this, alteration of the light:dark cycle and various chemical compounds were studied in anestrous Targhee and Finn-Targhee ewes. Ergocryptine was used (trial 1) because it has been shown to drastically lower plasma prolactin levels. Prolactin levels are high in summer months and are thought, by some, to be the cause of summer anestrous in ewes. Melatonin was also tested (trial 2) in an attempt to alter normal summer anestrous. Melatonin is a substance secreted by the pineal gland in response to darkness. As night length increases, the duration of the high melatonin levels increase, i.e., fall and winter. As night length decreases, melatonin duration also decreases, i.e., spring and summer. The characteristic pattern of melatonin secretion is thought to "signal" the ewe's system to initiate reproductive activity.

Prepared for Sheep Day, June 6, 1985.

Experimental Procedure

Trial 1

Fifty Finn-Targhee ewes aged 2 to 5 years were weighed and randomly allotted to one of five treatment groups on May 16, 1983. Treatments were (1) natural daylight (ND), (2) artificial lighting (8L:16D), (3) natural daylight plus 2.0 mg 2-bromo-α-ergocryptine (ergo) injected intramuscularly twice weekly (ND+ergo), (4) artificial lighting plus ergo injected im twice weekly (8L:16D+ergo) and (5) artificial lighting decreasing 1 hr per week over an 8-week period (16L:8D→8L:16D) and then held at 16 hr of dark for the remaining 7 weeks. Treatments 1 and 2 each also included ten 9-year-old Targhee ewes to compare breed effects. All other treatments involved ten Finn-Targhee ewes. Prior to the start of the experiment, all animals were paint branded and had their feet trimmed and necks shorn to facilitate bleeding. An intact, semen-tested Suffolk ram was randomly allotted to each treatment group. Grease mixed with branding paint was applied to the rams' bellies just ahead of the sheath twice daily to aid in estrous detection. Breeding marks were recorded at this time.

Animals in treatments 1 and 3 were kept in drylot with trees for shade at the SDSU Sheep Research Unit. All other treatment groups were housed in environmental chambers at the SDSU Animal Science Complex. Inside pens were scraped daily and washed twice weekly. All sheep were fed 5 lb. pellets (50% sun-cured alfalfa, 50% corn cobs) and 0.5 lb. rolled corn per head daily. On June 21 corn was decreased to 0.25 lb. and on August 1 was dropped from the ration because weekly weighings indicated excessive weight gain. Trace mineralized salt was available free-choice. The rams received an additional 0.5 lb. rolled corn per head daily. Temperatures inside were maintained near 74 F. Jugular blood samples were taken starting at 7 a.m. twice weekly to assay for serum levels of prolactin and progesterone by radioimmunoassay (RIA). The experiment was terminated on August 25, 1983. Subsequent to this, the ewes were exposed to a Columbia clean-up ram.

At lambing, ewe number, date and time of birth, birth weight, sex of lambs, type of birth and breed of sire were recorded.

Trial 2

Sixty Finn-Targhee ewes aged 2 to 6 years were weighed and randomly allotted to one of four treatment groups on June 1, 1984 (15 ewes/treatment). Treatments included (1) natural daylight (ND), (2) artificial lighting (8L:16D), (3) natural daylight plus 3.5 mg melatonin fed per ewe daily (ND+mel), and (4) artificial lighting plus 3.5 mg melatonin fed per ewe daily (8L:16D+mel). Prior to the start of the experiment, ewes were wormed, paint branded and had their feet trimmed and necks shorn to facilitate bleeding. An intact semen-tested Suffolk ram was randomly allotted to each treatment group. A grease and paint mixture was applied daily to each ram's belly just ahead of the sheath to aid in estrous detection. Breeding marks were recorded at this time.

Animals in treatments 1 and 3 were kept in drylot with metal roofing for shade at the SDSU Sheep Research Unit. Treatment groups 2 and 4 were kept in environmental chambers at the Animal Science Complex. Inside pens were scraped daily and washed twice weekly. Inside temperatures were maintained near 72 F. All sheep were fed 5 lb. pellets (75% corn cobs,25% sun-cured alfalfa) and 0.25 lb. rolled corn per head daily. Molasses was added to the corn for binding and dust reduction. Melatonin (3.5 mg/head/day) was dissolved in ethanol and added to the corn-molasses mixture. Rams were fed 1 lb. rolled corn per head per day (no melatonin). Free-choice trace mineralized salt was available. The lights came on inside at 11 a.m. Sheep were fed at approximately 1 p.m. in an attempt to keep serum melatonin levels high for 16 consecutive hr in groups 3 and 4.

Ewes were bled twice weekly, inside groups at 11 a.m. and outside groups at 7 a.m., so that all groups would be bled at approximately the same time after the end of the dark phase. Serum was assayed by RIA for prolactin, progesterone and melatonin. The experiment was terminated on August 24, 1984. Subsequent to this, ewes were exposed to a Columbia clean-up ram.

At lambing, ewe number, date and time of lambing, birth weight, sex of lamb, type of birth and breed of sire were recorded.

Prolactin and melatonin assays are not complete at this time.

Results and Discussion

Trial 1

The results of trial 1 are presented in table 1. Initial weights of ewes were similar. However, final weight for the 8L:16D+ergo treatment group was lighter (P<.05) than all other treatment groups. Reasons for this are unknown.

Nine of the ewes conceived within 20 days of the experiment's start. All of these were in the ND and ND+ergo treatment groups. This accounts for the early average conception date and early average lambing date for the 50% that did lamb. Average conception dates were May 29 and June 12 for the ND and ND+ergo groups, respectively. These differed (P<.05) from all inside treatments. It would appear that the ewes that conceived very early in the study were not anestrous at the time the trial was initiated. Progesterone values for some of these ewes were higher than expected, indicating that not all animals were anestrous. Why early conception occurred only in the natural daylight groups is not known. Ninety-five percent of the ewes in the controlled lighting groups lambed compared to 50% in the natural daylight treatment groups (P<.05).

Number of lambs per ewe lambing was greatest for ewes in the 8L:16D and 8L:16D+ergo treatment groups (2.6 lambs per ewe lambing), which differed (P<.05) from the ND ewes (1.6 lambs per ewe lambing). Average weight of lambs per ewe lambing was 24.6 lb. for the 8L:16D treatment group but only 16.1 lb. for the ND treatment group (P<.05). All other treatments did not differ. It appears that reduced light will hasten cyclic activity and increase conception in the normally anestrous ewe. However, ergocryptine seems to have no effect on initiating cyclic activity in anestrous ewes. A gradual increase in the length of the dark phase seems to have no additional benefit.

TABLE 1. EFFECT OF CONTROLLED LIGHTING AND ERGOCRYPTINE ON REPRODUCTIVE PERFORMANCE IN FINN-TARGHEE EWES (TRIAL 1)

	Treatment				
	ND	8L:16D	ND+ergo	8L:16D+ergo	16L:8D→8L:16D
No. ewes	10	10	10	10	10
Init. wt., lb.	149.8 ± 7.0	161.9 ± 7.0	149.4 ± 7.0	144.1 ± 7.0	162.1 ± 7.0
Final wt., lb.	183.9 ± 7.5[a]	184.6 ± 7.5[a]	169.0 ± 7.5[a]	155.1 ± 7.5[b]	183.0 ± 7.5[a]
Change wt., lb.	34.0 ± 4.4[a]	22.6 ± 4.4[ab]	19.7 ± 4.4[ab]	11.0 ± 4.4[b]	20.8 ± 4.4[ab]
Avg conception date	May 29[b]	July 7[a]	June 12[b]	July 11[a]	July 25[a]
No. ewes lambing	5[a]	8[b]	5[a]	10[b]	10[b]
Avg lambing date	Oct. 25[b]	Dec. 2[a]	Nov. 7[b]	Dec. 6[a]	Dec. 22[a]
No. lambs/ewe lambing	1.6 ± 0.32[b]	2.6 ± 0.25[a]	2.0 ± 0.32[b]	2.6 ± 0.23[a]	2.2 ± 0.23[ab]
Avg wt. lambs/ewe lambing, lb.	16.1 ± 2.6[b]	24.6 ± 2.0[a]	20.0 ± 2.6[ab]	21.3 ± 1.8[ab]	22.7 ± 1.8[ab]

[a,b] Figures in the same row with different superscripts differ ($P<.05$).

Figure 1 depicts progesterone and prolactin values for these ewes. Treatment affected both progesterone and prolactin ($P<.05$) as did week ($P<.05$). The interaction of treatment and week was significant ($P<.05$) for prolactin but not for progesterone. The effect of progesterone would be expected because, as animals begin cycling, conceiving and carrying young, progesterone will increase due to increased secretion by the corpus luteum on the ovary. The relative progesterone values are indicative of the percentage of ewes cycling in each treatment group. The treatment effect on prolactin stems mainly from the effects of ergocryptine injections, but differences also appear because of photoperiod. Since ergo depressed prolactin in both the ND+ergo and 8L:16D+ergo treatment groups but did not improve conception rate or other reproductive parameters, it can be concluded that depressed prolactin via ergo had no effect on improving reproductive performance in the anestrous ewe.

Table 2 compares the Finn-Targhee and Targhee ewes in the ND and 8L:16D treatment groups. Initial weights varied ($P<.05$), probably due to breed effects, although final weights were comparable.

Finn-Targhee in ND conceived an average of 38 to 39 days earlier than ewes of either breed in the 8L:16D treatment group ($P<.05$). Possible reasons for this were discussed earlier. The number of ewes lambing in each treatment and breed group did not differ ($P>.05$). However, pooled ND treatment data showed fewer ewes lambing ($P<.10$) than did pooled 8L:16D data across breeds. In the ND and 8L:16D treatment groups, the Finn-Targhee ewes averaged 0.6 and 1.0 more lambs per ewe lambing, respectively, than did the Targhee ewes ($P<.05$). However, total average weight of lambs born per ewe lambing did not differ in the ND treatment group ($P>.05$). Finn-Targhees in the 8L:16D group had 4.8 lb. more lamb per ewe lambing than did the Targhees in that group ($P<.05$). Other than differences caused by the Finn-Targhee's natural ability to conceive and carry more lambs to birth, there seems to be no breed differences between the two when using lighting regimes to induce ewes to cycle in the normal summer anestrous season.

Progesterone and prolactin assays have been run on weekly bleedings for these ewes. The 8L:16D treatment group had progesterone levels of 1.8 ± 0.08 ng/ml average, while the ND treatment group averaged 1.3 ± 0.08 ng/ml throughout the experiment. 8L:16D treated ewes reached higher progesterone levels as time increased than did those in the ND treatment group ($P<.05$). There was an interaction of treatment and week ($P<.05$). On the average, Finn-Targhees had a higher progesterone level per week than did the Targhees ($P<.05$), probably due to an increased number of corpora lutea in the Finn-Targhees because of greater ovulation rates.

Prolactin values were affected by treatment ($P<.05$). The 8L:16D treatment lowered prolactin levels to an average of 135.5 ± 12.5 ng/ml, while the ND treated ewes' levels remained at an average of 266.2 ± 12.5 ng/ml. Week also affected level ($P<.05$). Overall, the 8L:16D treatment group prolactin levels declined with time, but the ND treatment levels remained elevated. Breed appeared to have no effect on prolactin level.

Figure 1: Progesterone and prolactin values for Finn-Targhees in Trial 1.

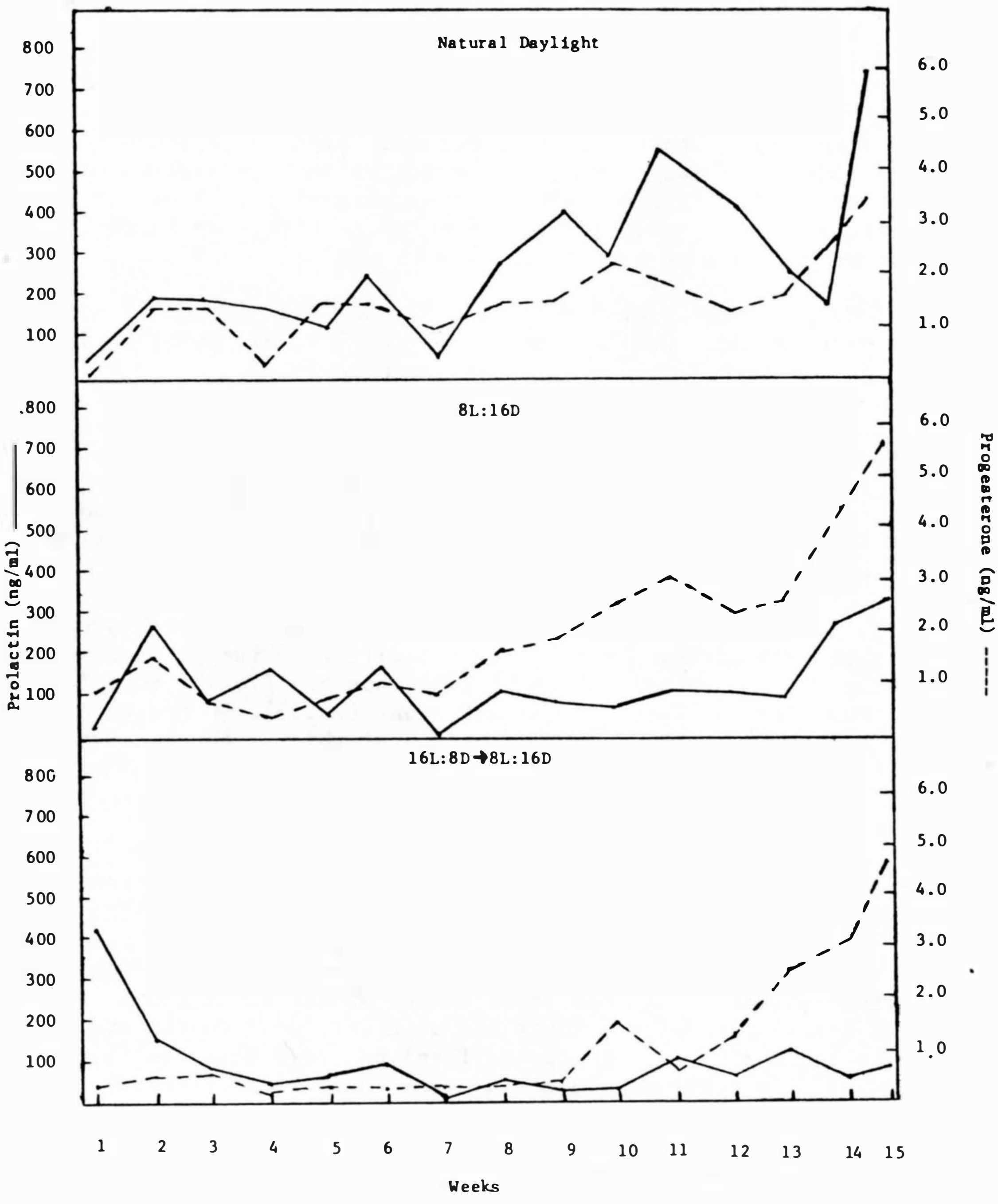

Figure 1 (cont.): Progesterone and prolactin values for Finn-Targhees in Trial 1.

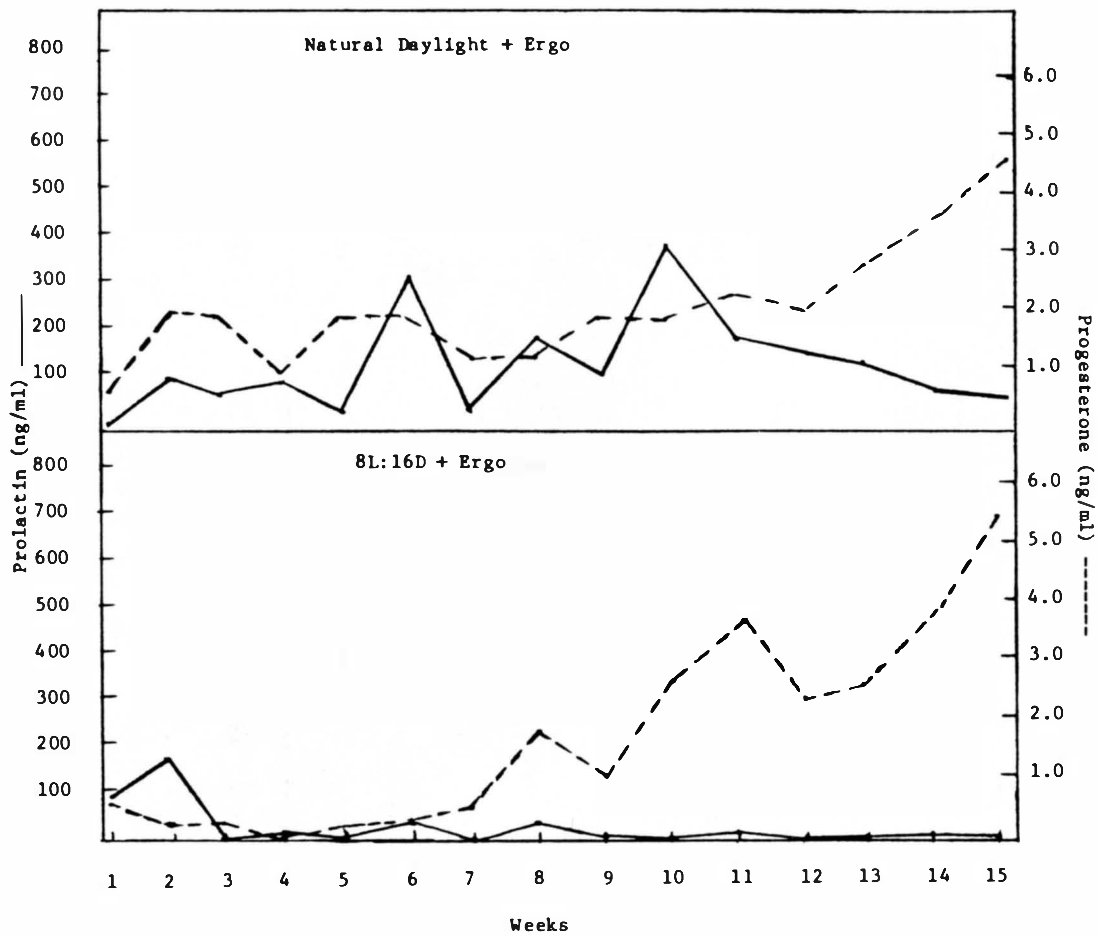

TABLE 2. EFFECT OF CONTROLLED LIGHT ON TARGHEE AND FINN-TARGHEE EWES (TRIAL 1)

	Treatment			
	ND		8L:16D	
	Targhee	Finn-Targhee	Targhee	Finn-Targhee
No. ewes	10	10	10	10
Init. wt., lb.	135.1 ± 5.7^{a}	149.8 ± 5.7^{ab}	146.3 ± 5.7^{ab}	161.9 ± 5.7^{b}
Final wt., lb.	173.1 ± 5.9	183.9 ± 5.9	168.5 ± 5.9	184.6 ± 5.9
Change weight, lb.	38.1 ± 5.2	34.0 ± 5.2	22.3 ± 5.2	22.6 ± 5.2
Avg conception date	June 22^{abc}	May 29^{a}	July 8^{bc}	July 7^{c}
No. ewes lambing	6	5	10	8
Avg lambing date	Nov. 18^{abc}	Oct. 25^{a}	Dec. 3^{bc}	Dec. 2^{c}
No. lambs/ewe lambing	$1.0 \pm .19^{a}$	$1.6 \pm .21^{b}$	$1.6 \pm .15^{b}$	$2.6 \pm .17^{c}$
Avg wt. lambs/ewe lambing, lb.	$13.6 \pm .21^{a}$	$16.1 \pm .21^{ab}$	19.8 ± 1.5^{b}	24.6 ± 1.7^{c}

^{a,b,c} Figures in the same row with different superscripts differ ($P<.05$).

Trial 2

The results of trial 2 are presented in table 3. Initial and final weights of all ewes as well as weight change throughout the experiment were similar (P>.05). The number of breeding marks received per ewe and days to first mark were not different (P>.05). The earliest average conception date was July 26 for ewes in the 8L:16D+mel group, which was 10 days earlier (P<.05) on the average than ewes in the ND group.

ND and ND+mel treated ewes had 16.1 and 15.6 lb. lamb born per ewe lambing, respectively, while the 8L:16D and 8L:16D+mel treated ewes had 23.1 and 22.4 lb. lamb born per ewe lambing, respectively (P<.05). Number of lambs born per ewe lambing was an average of 1.7 lb. in the ND and ND+mel groups and an average of 2.35 lambs in the 8L:16D and 8L:16D+mel groups (P<.05). The percentage of ewes lambing was lower (P<.05) for ND-treated ewes than for all other treatment groups (40.0% vs 95.2%, respectively). One ewe died and two ewes aborted in the ND+mel group and were therefore deleted. However, the two that aborted were carrying lambs conceived during the experimental period. It, therefore, appears that reduced light (8L:16D) and(or) melatonin feeding will increase cyclic activity and conception in normally anestrous ewes.

Progesterone assays were run on weekly bleedings (see figure 2). Treatment affected progesterone values (P<.05) as did week of bleeding (P<.05) and the interaction of week and treatment (P<.05). Higher levels of serum progesterone (>1.0 ng/ml) were reached and maintained approximately 3 weeks earlier in 8L:16D, 8L:16D+mel and ND+mel ewes than in ND ewes, indicating earlier cycling.

Conclusions

Artificially decreased daylight (8L:16D) and(or) feeding melatonin was effective in initiating reproductive activity in the ewe during summer anestrous, although ergocryptine was not. Both of these methods (8L:16D and feeding melatonin) increased estrous activity and increased the number of ewes conceiving. Results of these experiments are intriguing, but more research needs to be done on feeding melatonin to make it a feasible and successful method of causing a continuous breeding season in the ewe.

TABLE 3. EFFECT OF CONTROLLED LIGHTING AND MELATONIN ON REPRODUCTIVE PERFORMANCE IN EWES (TRIAL 2)

	Treatment			
	ND	8L:16D	ND+mel	8L:16D+mel
No. ewes	15	15	12	15
Init. wt., lb.	154.0 ± 5.1	154.0 ± 5.1	157.9 ± 4.9	143.7 ± 5.8
Final wt., lb.	165.3 ± 6.6	170.9 ± 5.3	172.4 ± 5.6	159.1 ± 5.3
Change wt. lb.	11.3 ± 3.8	16.7 ± 2.7	14.5 ± 1.7	15.4 ± 2.8
Avg conception date	Aug. 5[a]	Aug. 2[ab]	July 27[ab]	July 26[b]
No. ewes lambing	6[a]	15[b]	11[b]	14[b]
Avg. lambing date	Dec. 31[a]	Dec. 28[ab]	Dec. 22[ab]	Dec. 21[b]
No. lambs/ewe lambing	1.5 ± .21[a]	2.3 ± .19[b]	1.8 ± .26[a]	2.4 ± .27[b]
Avg wt. lambs/ewe lambing, lb.	16.1 ± 2.0[a]	23.1 ± 1.5[b]	15.6 ± 1.5[a]	22.4 ± 1.6[b]

[a,b] Figures in the same row with different superscripts differ ($P<.05$).

Figure 2: Progesterone values for Trial 2.