

7-11 SYNCH

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Prologue

Precise control of estrous cycles in cattle requires the synchronization of follicular growth, and synchronized luteal regression. The “7-11 Synch” protocol (Figure 1) that designed to: 1) shorten the treatment period from the 14-17 d or 14-19 d melengestrol acetate (MGA)-prostaglandin F_{2α} (PG) programs without reducing fertility; and 2) improve synchrony of estrus by synchronizing development and ovulation of follicles from the first wave of development. This review includes three published studies involving the 7-11 Synch protocol including: 1) “Development of an estrus synchronization protocol for beef cattle with short-term feeding of melengestrol acetate: 7-11 Synch” (Kojima et al., 2000); 2) “A fixed-time AI program for beef cows with 7-11 Synch” (Kojima et al., 2002); and 3) “Comparison of melengestrol acetate-based estrus synchronization protocols in yearling beef heifers” (Kojima et al., 2001).

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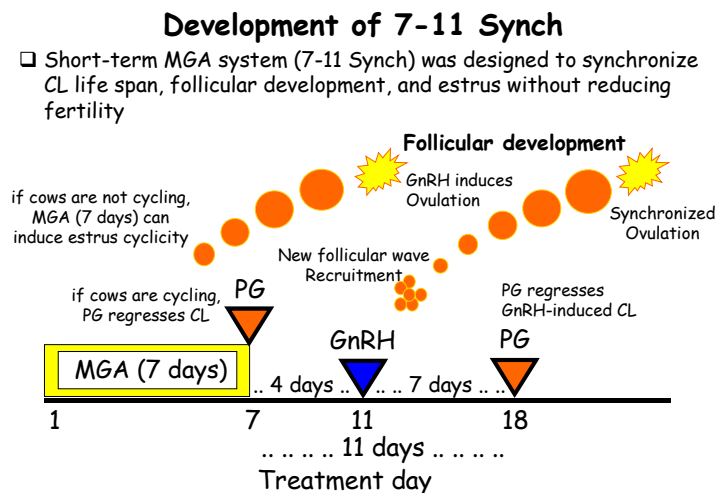


Figure 1. Illustration of 7-11 Synch protocol. MGA = melengestrol acetate; PG = prostaglandin F_{2α}.

DEVELOPMENT OF AN ESTRUS SYNCHRONIZATION PROTOCOL FOR BEEF CATTE WITH SHORT TERM FEEDING OF MELENGESTROL ACETATE 7-11 SYNCH¹

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Abstract

An estrus synchronization protocol (7-11 Synch) was developed to synchronize the first follicular wave and timing of ovulation in postpartum beef cows. In Exp. 1, follicular development and timing of ovulation in response to the following protocol were evaluated. Beef heifers (n=12) and cows (n=6), at random stages of the estrous cycle, were fed melengestrol acetate (MGA: .5 mg·cow⁻¹·d⁻¹) for 7 d and injected with PGF_{2α} (PG: 25 mg) on the last day of MGA. A second injection of PG was administered 11 d after cessation of MGA. After the second injection of PG, estrus was synchronized in 6/12 heifers and 3/6 cows. The interval to estrus in heifers and cows was 54 and 64 h, respectively ($P > .10$). All animals exhibiting estrus ovulated first wave follicles. Animals that failed to respond to the second injection of PG were in estrus later than 6 d after cessation of MGA and had corpora lutea that were unresponsive to the injection of PG. Based on the variation in interval to estrus following the first PG injection on the last day of MGA feeding in Exp. 1, an injection of GnRH (100 µg) was added to the protocol 4 d after the cessation of MGA to ensure ovulation or luteinization of dominant follicles and synchronization of first wave follicular development. This revised protocol was termed "7-11 Synch". In Exp. 2, two estrus synchronization protocols were compared. Multiparous beef cows were stratified by breed and postpartum interval and randomly assigned to the 7-11 Synch (n = 44) or Select Synch protocols (GnRH injection followed by PG injection 7 d later: n=45). Timing of estrus after the last PG injection (0 h) ranged from 42 to 102 h in the 7-11 Synch group and -30 to 114 h in the Select Synch group. Eight cows (18 %) in the Select Synch group exhibited estrus 30 h before to 18 h after PG. Synchronized estrus peaked between 42 to 66 h after the last PG injection with a maximum number of cows in estrus at 54 h for both treatment groups. Synchrony of estrus from 42 to 66 h was greater ($P < .05$) in 7-11 Synch (91 %: 41/44) than for Select

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Synch treated cows (69 %: 31/45). AI pregnancy rate from 42 to 66 h was greater ($P < .05$) in the 7-11 Synch group (66 %: 29/44) than in the Select Synch group (40 %: 18/45). In summary, the 7-11 Synch protocol improved synchrony of estrus without reducing fertility. This protocol has potential future application for fixed-time AI in beef cattle production systems.

Keywords: Estrus Synchronization, Artificial Insemination, Beef Cows

Introduction

Precise control of estrous cycles in cattle requires the synchronization of follicular growth, and synchronized luteal regression. Feeding melengestrol acetate (MGA) for 14 days ($.5 \text{ mg}\cdot\text{head}^{-1}\cdot\text{d}^{-1}$) followed by an injection of $\text{PGF}_{2\alpha}$ (PG) 17 days after MGA feeding (14/17-d MGA/PG protocol) is an effective method of estrous cycle control in heifers (Brown et al., 1988; Patterson and Corah, 1992). Recently, an increase in estrus response, synchronized conception, and pregnancy rates, and fecundity in the postpartum cow was reported among cows treated with the 14/17-d MGA/PG protocol when compared to PG alone (Patterson et al., 1995; Fralix et al., 1996). The advantages of using MGA for estrus synchronization include ease of administration and reasonable cost; however, length of the treatment protocol creates a need for increased management and, in some cases, extends the duration of the treatment period beyond practical limits.

Short-term feeding of MGA (5 or 7 d) combined with an injection of PG has been shown to be effective in synchronizing estrus in a high percentage of cattle when compared to untreated controls, PG or MGA alone, but fertility was reduced (Moody et al., 1978; Patterson et al., 1986; Beal et al., 1988; Chenault et al., 1990). A short-term MGA protocol, however, offers more flexibility in management of breeding animals compared to the currently available 14/17-d MGA/PG program (Patterson et al., 1989; Odde, 1990). Another advantage is that cows are further postpartum at the time of MGA treatment. Incorporation of MGA into an estrus synchronization program provides the opportunity to induce estrous cyclicity in peripubertal heifers (Imwalle et al., 1998) and anestrus postpartum beef cows (Fralix et al., 1996). Therefore, the objective of the present study was to develop an estrus synchronization program for beef cattle with short-term feeding of MGA that precisely synchronizes development of first wave follicles and timing of ovulation.

Materials and Methods

Experiment 1

Experimental Protocol. Crossbred beef heifers (n=12) and non-lactating beef cows (n=6), at random stages of the estrous cycle, were used to characterize changes that occur in cows and heifers that were treated with the new estrus synchronization protocol. Animals were fed MGA ($.5 \text{ mg}\cdot\text{head}^{-1}\cdot\text{d}^{-1}$) in a carrier pellet (CATTLE CHARGE, MFA Inc., Columbia, MO) for 7 d and injected with PG (25 mg Lutalyse Sterile Solution; Pharmacia and Upjohn, Inc., Kalamazoo, MI) on the last day of MGA feeding. A second injection of PG was given 11 d after cessation of MGA feeding (Figure 1).

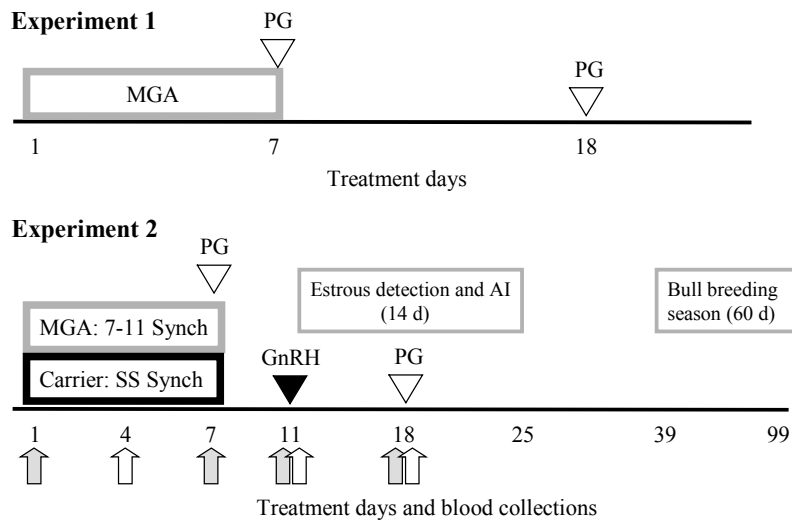


Figure 1. Illustration of the treatment schedule and events associated with both Experiment 1 and 2. MGA = melengestrol acetate, and PG = prostaglandin $F_{2\alpha}$. Arrows indicating the time blood samples were collected (solid arrow = 7-11 Synch, and gray arrow = Select Synch).

Estrus Detection and Ultrasonography. Behavioral estrus was observed every 6 h for 6 d following the last feeding of MGA and for 5 d following the second injection of PG. Development of first wave follicles and corpora lutea (CL) were monitored by real-time ultrasonography (Aloka 500V, Corometrics Medical Systems, Wallingford, CT) with a 7.5-MHz linear array transducer. Ultrasonography was performed every other day beginning at the last feeding of MGA through the second injection of PG, and every 12 h thereafter for 5 d, to determine the timing of ovulation.

Blood Collection and RIA. Blood samples were collected via jugular venipuncture at 10 and 2 d before the start of MGA feeding. Additional blood samples were collected on the last day of MGA feeding, 5, 7, and 9 d after MGA feeding, and daily for 5 d following the second injection of PG. Samples were collected into EDTA-treated tubes and placed immediately on ice. Within 4 h of collection, plasma was harvested by centrifugation and stored at -20°C until concentrations of progesterone were quantified by RIA within a single assay (Kirby et al., 1997: COAT-A-COUNT, Diagnostic Products Corporation, Los Angeles, CA). Intraassay coefficient of variation was 6.9% and assay sensitivity was 0.2 ng/mL.

Statistical Analysis. Intervals to the onset of estrus after MGA feeding and after the last injection of PG, diameter of dominant follicles, and timing of ovulation were analyzed by ANOVA using General Linear Models procedure of SAS (1988). Duncan's new multiple range test (Steel and Torrie, 1980) was used for mean separation.

Experiment 2

Experimental Protocol. Based on the results from Exp. 1, an injection of 100 μg GnRH (Cystorelin; Merial, Islin, NJ) was included in the treatment protocol 4 d following the last day of MGA feeding to ensure ovulation or luteinization of dominant

follicles and synchronization of the first follicular wave. This revised protocol was termed “7-11 Synch” (Figure 1). In Exp. 2, 89 multiparous beef cows with calves were stratified by breed and postpartum interval (range 15-77 d) and were randomly assigned to two estrus synchronization treatments, 7-11 Synch (n = 44) or Select Synch (n = 45). The Select Synch protocol was chosen to compare with 7-11 Synch because of similarity in the treatment schedules for injections of GnRH and PG (Figure 1).

All cows were fed a carrier pellet as described in Exp. 1, starting 3 d prior to the initiation of MGA treatment. The first day of MGA feeding was defined as Day 1 (d 1) of the experiment (Figure 1). Cows in the Select Synch group continued to receive carrier pellets for an additional 7 d (from d 1 to 7). Cows in the 7-11 Synch group were fed MGA ($.5 \text{ mg}\cdot\text{head}^{-1}\cdot\text{d}^{-1}$) in the carrier pellet for 7 d (from d 1 to 7) and received an injection of PG on the last day of MGA feeding (d 7). Four days after the last MGA feeding (d 11), GnRH was administered and a second injection of PG was given 11 d after the last day MGA was fed (d 18). Cows in the Select Synch group received an injection of GnRH (d 11), and then an injection of PG 7 d later (d 18).

Estrus Detection and AI. Cows were observed three times a day (0600, 1200, and 1900 h) for signs of behavioral estrus after the GnRH injection and for 7 d following the last injection of PG (from d 11 to 25). KAMAR heatmount™ detectors (KAMAR, Inc., Steamboat Springs, CO) were used to aid in detection of estrus. Timing of behavioral estrus was recorded for each cow. Body condition scores (BCS; 1 to 9 scale, 1 = emaciated, and 9 = obese) were recorded on all cows before insemination. Cows were artificially inseminated 12 h after detection of behavioral estrus by one of two experienced technicians and semen from three bulls was used (Select Sires, Inc., Plain City, OH). The number of cows in each treatment group that were inseminated by an individual technician was approximately equal. Cows were exposed for a 60-day natural service period beginning on d 39. Conception rate to AI or natural service was determined by a single technician by transrectal ultrasonography approximately 60 d after the last AI (approximately d 85). Pregnancy status was confirmed by rectal palpation approximately 120 d later and calving record.

Blood Collection and RIA. Blood samples were collected on d 1 and 7 from the 7-11 Synch group and on d4 and 11 from the Select Synch group to determine postpartum status (cyclic or anestrus). The blood collection schedule is shown in Figure 1. Cows were considered cyclic when concentrations of progesterone were greater than 1 ng/mL in at least one sample collected 7 d apart. Additional samples were collected on the day of GnRH injection (d 11) for the 7-11 Synch group and on the day of second PG injections (d 18) for both groups to determine presence of luteal activity. Sample collection was performed as described in Exp. 1. Concentrations of progesterone were quantified by RIA within a single assay as described in Exp. 1. Intra-assay coefficient of variation was 7.3% and assay sensitivity was 0.2 ng/mL.

Statistical Analysis. Synchrony of estrus, conception rate, and pregnancy rates during both the AI period (d 11 to 25) and peak response period were analyzed using Chi-square analysis, CATMOD procedure, of SAS (1988) including the fixed effects of treatment, breed, AI technician, AI sire, cyclicity status, BCS, number of days postpartum, and the interactions of each with treatment. The Fisher’s exact test (Steel and Torrie, 1980) was used for mean separation. Maximum estrus response occurred at 54 h for both treatment groups; therefore, “peak response” period was defined as 12 h before

(42 h) and 12 h after (66 h) the maximum estrus response (54 h). During the 24-h peak response period (42 to 66 h), 14, 73, and 5% of the cows in the 7-11 Synch group and 20, 36, and 13% of the cows in the Select Synch group exhibited estrus at 42, 54, and 66 h, respectively. Degree of synchrony was analyzed by ratio of variance (F-test) of mean time interval to onset of estrus. No breed x treatment interaction was observed ($P > .10$); therefore, all data from different breeds within a treatment group were pooled for analysis. No effect ($P > .10$) of AI technician, BCS, or number of days postpartum on pregnancy rates were observed, and those were removed from the model. Three AI sires were used in this experiment and were assigned to equal numbers of cows for each estrus synchronization protocol. Overall AI pregnancy rates of three AI sires, regardless of treatment, were not different (75, 52, and 76%: $P > .10$). Because no significant differences occurred in pregnancy rate among sires, AI sire was removed from the model.

Results

Experiment 1

The number of cattle exhibiting estrus within 7 d after MGA treatment and the interval to estrus were 10/12 and 96 ± 4.4 h (mean \pm SE), respectively, in heifers, and 4/6 and 84 ± 7.0 h, respectively, in cows. Timing of estrus did not differ ($P > .10$) between heifers and cows. After the second injection of PG, 6/12 heifers and 3/6 cows were synchronized. The interval to estrus was not different ($P > .10$) between heifers (54 ± 6.2 h) and cows (64 ± 4.0 h). All cattle exhibiting estrus after the second injection of PG ovulated first wave follicles and timing of ovulation did not differ ($P > .10$) between heifers (80 ± 7.4 h) and cows (96 ± 4.0 h). Cattle that failed to respond to the second injection of PG had either a cystic follicle ($n = 1$) or early developing CL that were not responsive to PG ($n = 8$). Early developing CL were the result of delayed estrus and ovulation after the last feeding of MGA. Diameter of dominant follicles at the time of the second PG injection tended to be larger ($P < .07$) in cows that were successfully synchronized compared to non-responders (16.0 ± 1.0 mm and 8.3 ± 2.8 mm, respectively). Among heifers, mean diameter of the dominant follicle did not differ ($P > .10$) between synchronized heifers and non-responders (14.1 ± 0.4 mm and 11.5 ± 2.2 mm, respectively).

Experiment 2

Average postpartum interval at the first PG injection on d 7 (7-11 Synch) or the GnRH injection on d 11 (Select Synch), and BCS before AI were not different ($P > .10$) between the 7-11 Synch (56 ± 2.4 d and 5.4 ± 0.04 , respectively) and Select Synch groups (60 ± 2.3 d and 5.4 ± 0.05 , respectively). The proportion of cows that were anestrous or cyclic at the GnRH injection was not different ($P > .10$) between the 7-11 Synch (34 %: 15/44, and 66 %: 29/44, respectively) and Select Synch groups (38 %: 17/45, and 62 %: 28/45, respectively).

Timing of estrus after the last PG injection (0 h) ranged from 42 to 102 h in the 7-11 Synch group (60-h period) and -30 to 114 h in the Select Synch group (144-h period; Figure 2). Synchrony of estrus during the 14-d AI period did not differ ($P > .1$) between 7-11 Synch (95 %: 42/44) and Select Synch treated groups (96 %: 43/45). Eight cows (18 %) in the Select Synch group exhibited estrus from -30 h to 18 h after PG injection. Synchronized estrus peaked at 54 h after the last PG injection for both the 7-11 Synch (73

32/44) and the Select Synch groups (36 %: 16/45). As indicated by the lower variance for mean interval to estrus analyzed by F-test, degree of estrus synchrony was greater ($P < .0001$) in the 7-11 Synch treated cows (111.6, $df = 41$) than for Select Synch treated cows (768.7, $df = 42$).

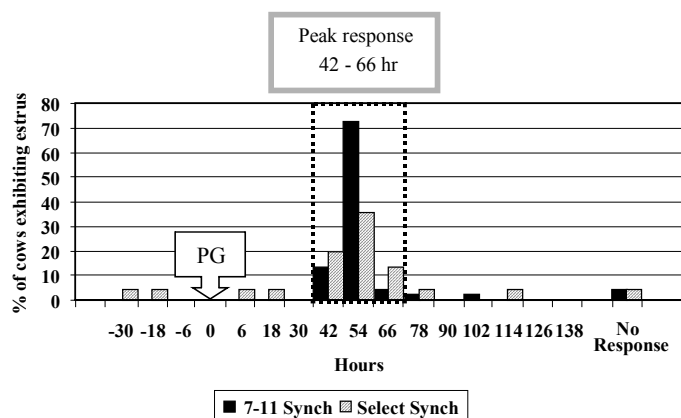


Figure 2. Distribution of estrous response in cows treated with either the 7-11 Synch or Select Synch protocols (Hour 0 = time of prostaglandin $F_{2\alpha}$ [PG] administration). Dash-line box indicated 24-h peak response period (42 to 66 h). Cows were observed three times a day (0600, 1200, and 1900 h) for behavioral estrus.

Overall AI pregnancy rates during the 14-d AI period (after the GnRH injection and for a 7-d period following the last injection of PG: from d 11 to 25) and overall pregnancy rates during the breeding season (14-d AI period followed by 60-d natural service) did not differ ($P > .10$) between treatments (7-11 Synch: 70%: 31/44, and 89%: 39/44, respectively; Select Synch: 69%: 31/45, and 91%: 41/45, respectively).

Synchrony of estrus during the peak response period (42 to 66 h: 24-h period) was greater ($P < .05$) in 7-11 Synch (91%: 40/44) than in Select Synch treated cows (69%: 31/45; Figure 3). Consequently, AI pregnancy rate during the peak response period was greater ($P < .05$) in the 7-11 Synch group (68%: 30/44) than in the Select Synch group (47%: 21/45; Figure 4). During the peak response period, greater synchrony of estrus ($P < .05$) was observed in cyclic cows treated with the 7-11 Synch protocol than with the Select Synch protocol, resulting in greater ($P < .05$) AI pregnancy rates; anestrous cows responded similarly ($P > .10$) to these treatments (Figures 3 and 4).

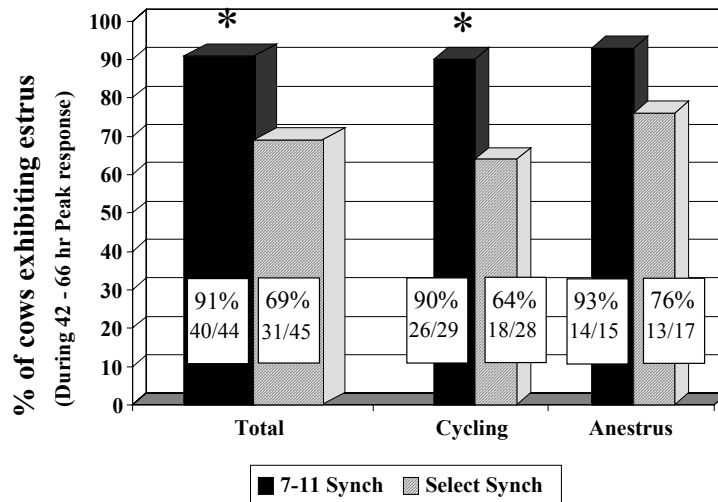


Figure 3. Estrous response (number of cows detected in estrus / total number of cows treated) of the 7-11 Synch or Select Synch treated cows during the 24-h (42 to 66 h) peak response period. * = Estrous response was greater ($P < .05$) for total and cyclic cows treated with the 7-11 Synch protocol compared with the Select Synch protocol.

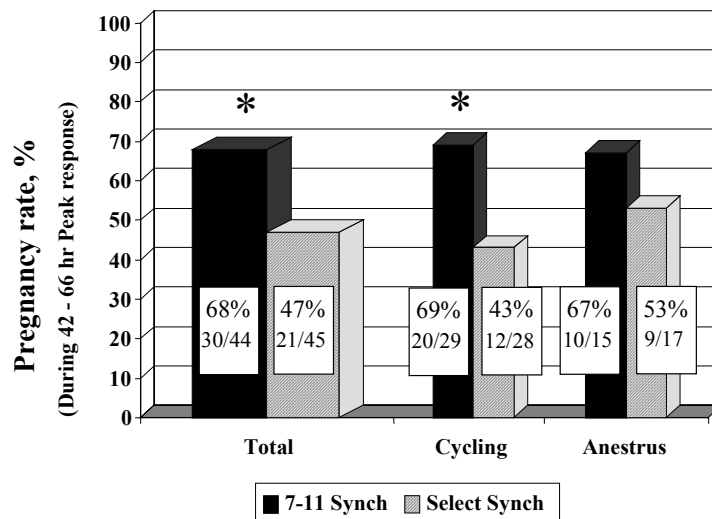


Figure 4. AI pregnancy rates (number of cows AI / total number of cows treated) of the 7-11 Synch or Select Synch treated cows during the 24-h (42 to 66 h) peak response period. * = Pregnancy rates were greater ($P < .05$) for total and cyclic cows treated with the 7-11 Synch protocol compared with the Select Synch protocol.

At the time of the last PG injection, three observations were made based on blood samples for progesterone: 1) cows with concentrations of progesterone greater than 1 ng/mL, indicating presence of a functional CL; 2) concentrations of progesterone ranging

from 0.3 to 1 ng/mL, suggesting the possible presence of luteinized follicles; and 3) no detectable concentrations of progesterone (< 0.2 ng/mL; below the assay sensitivity). Sixty-eight percent of cows in the 7-11 Synch group had concentrations of progesterone > 1ng/mL at the time of the last PG injection (30/44: anestrus 10/15 and cyclic 20/29), and 32% had concentrations of progesterone between 0.3-1 ng/mL (14/44: anestrus 5/15 and cyclic 9/29). For cows in the Select Synch group, 58% had concentrations of progesterone > 1 ng/mL (26/45: anestrus 9/17 and cyclic 17/28); 22% had concentrations of progesterone between 0.3-1 ng/mL (10/45: anestrus 6/17 and cyclic 4/28); and 20% had no detectable concentrations of progesterone (9/45: anestrus 2/15 and cyclic 7/28). All cows in the 7-11 Synch group had detectable progesterone concentrations (> 0.3 ng/mL) compared with 80% (36/45) in the Select Synch group. These data suggest that the 7-11 Synch protocol successfully induced CL or resulted in the formation of lutenized follicles capable of responding to PG.

Discussion

Precise control of estrous cycles in cattle requires the synchronization of follicular growth, and synchronized luteal regression. The new treatment tested in these experiments was designed to: 1) shorten the treatment period compared to a 14/17-d MGA/PG program without reducing fertility; and 2) improve synchrony of estrus by synchronizing development and ovulation of follicles from the first wave of development compared to currently available estrus synchronization protocols.

A high percentage of cattle can be expected to exhibit estrus 3 to 5 d after short-term feeding of MGA (Moody et al., 1978; Patterson et al., 1986; Beal et al., 1988; Chenault et al., 1990). These cattle would be on days 6 to 8 of the estrous cycle at the time of the proposed second injection of PG 11 d later (Exp. 1). Consequently, CL should respond to the injection of PG and the existing dominant follicles should ovulate. Cattle that failed to respond to the second PG injection in Exp. 1 had either a cystic follicle (n = 1) or early developing CL (n = 8). Early developing CL were caused by delayed estrus and ovulation after the last feeding of MGA. Although a decline in concentrations of progesterone was observed after the last day of MGA feeding and the first PG injection, timing of estrus and ovulation was delayed in cows that did not respond to this treatment. Variation in expression of estrus following MGA feeding may be related to differences in clearance of MGA among individual cattle (Kojima et al., 1995). In fact, MGA can be stored in adipose tissue and released at different rates for individual cattle after withdrawal of MGA from the feed (Neff, 1983); therefore, body condition and/or amount of MGA consumed would affect clearance of MGA and consequently the timing of estrus and ovulation after the last day of MGA feeding. Another possibility for delayed estrus is that some animals may have been in the latter portion of the follicular wave at the end of MGA feeding at the time PG was administered. Hence, initiation of the new follicular wave occurred after the first injection of PG, which resulted in delayed expression of estrus.

An injection of GnRH was added to this estrus synchronization protocol 4 d after the last day of MGA feeding to ensure ovulation or luteinization of dominant follicles and synchronization of first wave follicular development, and to determine whether synchrony of estrus could be improved (Exp. 2). Timing of the GnRH injection was determined by the expected day of MGA clearance based on results from Exp. 1 and

previous literature (Moody et al., 1978; Patterson et al., 1986; Beal et al., 1988; Chenault et al., 1990).

The relationship between follicular development and timing of GnRH injection in estrus synchronization protocols may differ between anestrous and cyclic cows; however, both cyclic and anestrous cows responded equally well to the 7-11 Synch protocol. Although the number of anestrous cows in the present study was small, timing of estrus, estrus response, and pregnancy rates of anestrous cows were similar to those of cyclic cows.

The 7-11 Synch protocol resulted in a higher degree of estrus synchrony and greater AI pregnancy rates during a 24-h peak response period (42 to 66 h) compared to the Select Synch protocol. The interval to peak estrus response (42 to 66 h) in 7-11 Synch treated cows was similar to that observed in Exp. 1. These results agree with previous studies when cyclic cattle were injected with PG during the early (d 5 to 7) portion of the estrous cycle (Tanabe and Hann, 1984; Watts and Fuquay, 1985). These data indicate that the 7-11 Synch protocol effectively synchronized the first wave of follicular development resulting in a fertile estrus in both anestrous and cyclic cows.

Concentrations of progesterone at the time of the last injection of PG demonstrated that the injection of GnRH in the 7-11 Synch protocol successfully resulted in ovulation or luteinization of dominant follicles followed by initiation of new follicular waves. Either CL or luteinized follicles induced by GnRH would be capable of responding to PG; therefore, a relationship may exist between concentrations of progesterone before PG and improved synchrony of estrus for cows treated with the 7-11 Synch protocol. Consequently, follicles from the first wave ovulated after the second injection of PG, resulting in an earlier estrus response compared to the interval typically observed in cows injected with PG during the mid- to late estrous cycle (approximately 70 to 75 h; Tanabe and Hann, 1984; Watts and Fuquay, 1985). Although a decreased estrus response was reported in earlier studies when cattle were injected with PG during d 5 to 7 of the estrous cycle (Tanabe and Hann, 1984; Watts and Fuquay, 1985), cows assigned to the 7-11 Synch protocol demonstrated excellent synchrony of estrus when PG was administered on approximately d 7 of the estrous cycle. Further study is necessary to confirm effectiveness of the 7-11 Synch protocol in anestrous cows and peripubertal heifers. It would appear that 7-11 Synch may offer the potential for fixed-time AI programs because of the high degree of estrus synchrony exhibited by cows on this treatment.

In general, GnRH-PG based protocols are economical and less labor intensive compared to other protocols currently available (Twagiramungu et al., 1992; Pursley et al., 1995). The drawback of these protocols is that approximately 5 to 15% of the cyclic cows exhibit estrus prior to and immediately after the time PG is administered, resulting in the need for increased length of time to detect estrus or decreased response during the synchronized period after PG injection (Pursley et al., 1995; Twagiramungu et al., 1995). In Experiment 2, 9% (4/45) of the cows in the Select Synch group exhibited estrus after the GnRH injection and before PG (-30 to 0 h), and another 9% (4/45) exhibited estrus immediately after the injection of PG (0 to 18 h), necessitating a prolonged period of estrus detection and AI. Additionally, these cows did not have detectable concentrations of progesterone at the time of PG; of which 4 cows (1 anestrous and 3 cyclic) exhibited estrus after GnRH and before PG (-30 to 0 h). Another 4 cows (4 cyclic) exhibited estrus

immediately after injection with PG (0 to 18 h), and one anestrous cow did not respond to the treatment. These observations indicate that those cows did not respond to the injection of GnRH and exhibited estrus regardless of the treatment. This is in agreement with the previous report that Select Synch treated cows that exhibit estrus early are in the late portion of the estrous cycle (d15 to 17) at the time GnRH is administered (Downing et al., 1998).

The advantages of MGA for synchronization of estrus are ease of administration and low cost. Furthermore, MGA recently received clearance from FDA for use in reproductive classes of beef cattle and dairy heifers (Federal Register, 1997); therefore, research of estrus synchronization methods involving MGA bears increased significance and marked relevance to current industry needs. However, other progestin treatments (i.e. Controlled Intravaginal Drug Release [CIDR], Progesterone Releasing Intravaginal Device [PRID] or Norgestomet implants [as in SYNCRO-MATE-B treatment]) could be used in place of MGA feeding in the 7-11 Synch system, offering a variety of alternatives to fit individual needs. In summary, the 7-11 Synch protocol improved synchrony of estrus in both cyclic and anestrous cows without reducing fertility. This protocol provides potential future application in estrus synchronization and fixed-time AI programs for use in beef cattle production systems.

Implications

The advantages of the 7-11 Synch protocol compared to a 14/17-d MGA/PG program include: 1) shorter treatment period; and 2) improved synchrony of estrus. Improved synchrony of estrus should reduce labor costs associated with estrus detection and offset the increased treatment cost of this protocol compared to other estrus synchronization protocols currently available. The drawback associated with 7-11 Synch is that cattle need to be worked 4 times to successfully administer the treatment and AI the cows. The 7-11 Synch protocol, however, provides potential future application in estrus synchronization and fixed-time AI programs for use in beef cattle production systems.

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A FIXED-TIME AI PROGRAM FOR BEEF COWS WITH 7-11 SYNCH^{1,2}

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Abstract

The 7-11 Synch protocol for synchronization of estrus in beef cows results in a tightly synchronized estrus response that generally peaks at 54 h following treatment. The objectives of this study were: 1) to determine the potential for fixed-time AI of beef cows using 7-11 Synch; and 2) to determine whether the addition of GnRH at AI improves pregnancy rates resulting from fixed-time AI. Field trials were conducted at three locations (location 1, n = 90; location 2, n = 120; and location 3, n = 171). Cows were managed at each location in two or three separate herds (herd 1A, 1B, 2A, 2B, 2C, 3A, 3B, or 3C) based on cow age. Cows at each location and within each herd were stratified by age, days postpartum, and body condition score, and randomly assigned to one of two treatments at AI. All cows were synchronized with the 7-11 Synch and were fed melengestrol acetate (MGA: 0.5 mg•hd⁻¹•d⁻¹) for 7 d followed by injections of prostaglandin F_{2α} (PG: 25 mg Lutalyse[®]) on d 7 of MGA, GnRH (100 µg Cystorelin[®]) on d 11, and PG on d 18. Fixed-time AI was performed 60 h after the last PG with or without GnRH at the time of AI. AI pregnancy rate was determined by ultrasonography 40 to 60 d after AI. Data were analyzed for each herd separately based on the interaction (P < 0.05) among location, herd, age, and AI sire on AI pregnancy rate. There was no difference (P > 0.10) in pregnancy rate resulting from fixed-time AI based on whether or not cows received GnRH at AI. AI pregnancy rates with or without GnRH at AI for each herd were: 1A, 70 % (28/40) and 60 % (24/40); 1B, 44 % (4/9) and 33 % (3/9); 2A, 65 % (22/34) and 73 % (24/33); 2B, 64 % (7/11) and 80 % (8/10); 2C, 53 % (8/15) and 35 % (6/17); 3A, 68 % (15/22) and 43 % (9/21); 3B, 55 % (22/40) and 41 % (16/39); and 3C, 31 % (8/26) and 48 % (11/23), respectively. These data indicate that 7-11 Synch provides significant opportunity to AI cows at a fixed time with resulting high fertility, eliminating the need to detect estrus. Further research is needed to more precisely determine the appropriate time of AI and the necessity of administering GnRH at AI.

Key words: Beef Cows, Estrus Synchronization, Fixed-time AI

Introduction

Genetic improvement of economically important traits in beef cattle can be achieved most rapidly through selection of genetically superior sires and widespread use of artificial insemination (AI). Currently, however, less than 5 % of cow-calf operations in the United States practice AI or utilize any form of estrus synchronization (NAHMS, 1994). The lack of time/labor was the most common reason for not utilizing AI and estrus

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synchronization (NAHMS, 1994). In order to facilitate use of AI and estrus synchronization by cow-calf operations, the development of effective estrus synchronization protocols that allow fixed-time AI without need of estrus detection and resulting high fertility is required.

We previously developed the 7-11 Synch protocol for beef cows which improved synchrony of estrus by effectively synchronizing the first wave of follicle development and ovulation (Kojima et al., 2000). Estrus response following this protocol generally peaks at 54 h (ranging from 42 to 66 h) and more than 90 % of beef cows expressed estrus during this period (Kojima et al., 2000). Because of the tight synchrony of estrus, fixed-time AI at 60 h following the 7-11 Synch protocol may not require an injection of GnRH at the time of AI, whereas all available fixed-time AI protocols require an injection of GnRH at AI.

The objectives of this study were: 1) to determine the potential for fixed-time AI of beef cows using the 7-11 Synch protocol; and 2) to determine whether the addition of GnRH injection at AI improves pregnancy rates resulting from fixed-time AI at 60 h following the 7-11 Synch protocol.

Materials and Methods

Experimental Design. Field trials were conducted during the 2001 fall breeding season at three locations (location 1, n = 98; location 2, n = 120; and location 3, n = 171). Angus-based crossbred cows were managed at each location in two or three separate herds (herd 1A, 1B, 2A, 2B, 2C, 3A, 3B, or 3C) based on cow age. Cows at each location and within each herd were stratified by age, days postpartum (day of treatment initiation), and body condition score (BCS; 1 to 9 scale, 1 = emaciated, and 9 = obese), and randomly assigned to one of two treatments at AI (Table 1).

Herd	Cows (n)	Age	Days postpartum ^a	BCS	Table 1. Number of cows, age, days postpartum, and body condition score (BCS) in each herd (mean ± SE).
1A	80	5.4 ± 0.1 ^c	49.2 ± 2.4 ^c	5.9 ± 0.1 ^c	
1B	18	2.0 ± 0.0 ^d	44.7 ± 5.9 ^c	5.4 ± 0.2 ^d	
2A	67	7.0 ± 0.4 ^b	48.3 ± 3.7 ^c	5.1 ± 0.1 ^c	
2B	21	2.6 ± 0.1 ^d	55.6 ± 4.8 ^c	4.9 ± 0.1 ^c	
2C	32	2.0 ± 0.1 ^d	56.3 ± 4.9 ^c	5.4 ± 0.1 ^d	
3A	43	2.0 ± 0.0 ^d	70.5 ± 1.7 ^b	5.4 ± 0.1 ^d	
3B	79	5.2 ± 0.3 ^c	49.0 ± 1.0 ^c	6.3 ± 0.1 ^b	
3C	49	6.5 ± 0.3 ^b	51.5 ± 1.4 ^c	5.8 ± 0.1 ^c	

^a Means reflect days postpartum for cows in each herd on the first day of melengestrol acetate (MGA) feeding.

^{b,c,d,e} Unlike superscripts within a column differ (P < 0.05).

All cows synchronized with the 7-11 Synch protocol, were fed melengestrol acetate (MGA: 0.5 mg•hd⁻¹•d⁻¹) in a grain carrier for 7 d (from d 1 to d 7), and received an injection of prostaglandin F_{2α} (PG: 25 mg Lutalyse[®] Sterile Solution, Pharmacia Animal Health, Kalamazoo, MI) on the last day of MGA feeding (d 7). Four days after the last MGA feeding (d 11), injection of GnRH (100 µg Cystorelin[®], Merial, Athens, GA)

was given, and a second injection of PG was given 11 d after the last MGA feeding (d 18). Fixed-time AI was performed 60 h after the last injection of PG with or without an injection of GnRH at the time of AI (Figure 1).

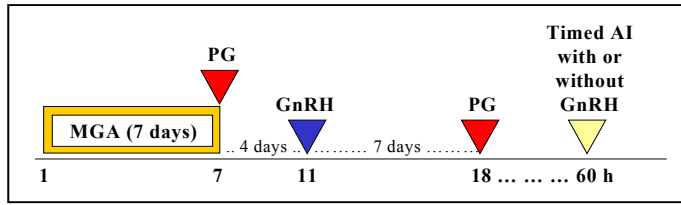


Figure 1. Treatment schedule for the estrus synchronization (7-11 Synch) and fixed-time AI. (MGA = melengestrol acetate; and PG = prostaglandin F^{2a})

Cows at each location and within each herd were stratified by age, days postpartum, BCS, and treatment groups, and randomly assigned to one of two experienced AI technicians. Number of cows in each treatment group at each location and within each herd that were inseminated by an individual technician was approximately equal. Number of AI sires used in these trials was 2, 6, and 4 at location 1, 2, and 3, respectively. Pregnancy rate to AI was determined by ultrasonography (Aloka 500V equipped with 5.0 MHz linear-array transducer, Aloka, Wallingford, CT) 40 to 60 d after AI by a single technician.

Statistical Analyses. Effects of treatment on fixed-time AI pregnancy rates were analyzed by Chi-square analysis, and the interaction between variables (location, herd, age, days postpartum, BCS, and AI sire) on AI pregnancy rate was also analyzed (StatView[®], SAS institute Inc., Cary, NC). The AI pregnancy rates were defined as the percentage of animals pregnant at 40 to 60 d after the fixed-time AI.

Results and Discussion

There were differences ($P < 0.05$) in age of cows, days postpartum, and BCS within location and between herds (Table 1). Data were analyzed for each herd separately based on the interaction ($P < 0.05$) among location, herd, age, and AI sire on fixed-time AI pregnancy rate. When data were analyzed for each herd separately, fixed-time AI pregnancy rates were not different ($P > 0.10$) between treatments (with GnRH or without GnRH: Table 2). Pregnancy rates to AI with GnRH resulted in 57.9 % (114/197) and ranged from 31 % to 70 %, while pregnancy rates to AI without GnRH resulted in 52.6 % (101/192) and ranged from 33 % to 80 %.

Herd	Cows (n)	with GnRH	without GnRH
1A	80	70 % (28/40)	60 % (24/40)
1B	18	44 % (4/9)	33 % (3/9)
2A	67	65 % (22/34)	73 % (24/33)
2B	21	64 % (7/11)	80 % (8/10)
2C	32	53 % (8/15)	35 % (6/17)
3A	43	68 % (15/22)	43 % (9/21)
3B	79	55 % (22/40)	41 % (16/39)
3C	49	31 % (8/26)	48 % (11/23)
Total	389	58 % (114/197)	53 % (101/192)
Range		31 – 70 %	33 – 80 %

Table 2. Pregnancy rates to fixed-time AI at 60 h after the 7-11 Synch with or without GnRH at the time of AI in each herd^a.

^a Interaction among location, herd, age, and AI sire on AI pregnancy rate ($P < 0.05$).

The 7-11 Synch protocol has resulted in the tightest estrus synchrony (peaking at 48 to 60 h after the last PG) among all estrus synchronization protocols we have tested (Kojima et al., 2000; Stegner et al., 2001). Because of the tight synchrony of estrus this treatment provides, 7-11 Synch is perhaps the best available alternative to use with fixed-time AI. Increased use of AI and rapid genetic improvement in U.S. beef herds could be facilitated if reliable fixed-time AI programs were developed. Results from the present study demonstrate the potential for the development of fixed-time AI programs based on the 7-11 Synch protocol.

The 7-11 Synch protocol provides significant opportunity to AI cows at a fixed time with resulting high fertility, eliminating the need to detect estrus. Further research is needed to more precisely determine the appropriate time of AI and the necessity of administering GnRH at AI.

Implications

The 7-11 Synch protocol provides significant opportunity to AI cows at a fixed time with resulting greater fertility, eliminating the need to detect estrus. Further research is needed to more precisely determine the appropriate time of AI and the necessity of administering GnRH at AI.

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COMPARISON OF MELENGESTROL ACETATE-BASED ESTRUS SYNCHRONIZATION PROTOCOLS IN YEARLING BEEF HEIFERS^{1,2}

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Introduction

Feeding melengestrol acetate (**MGA**) at 0.5 mg·hd⁻¹·d⁻¹ for 14 d followed by an injection of prostaglandin F_{2α} (**PG**) 17 d after MGA withdrawal was found to be an effective method of estrous cycle control in beef heifers (Brown et al., 1988; Patterson and Corah, 1992). Studies show that synchrony of estrus and total estrus response were improved in beef heifers when PG was administered 19 days, instead of 17 days, after MGA withdrawal (Nix et al., 1998; Deutscher et al., 2000; Lamb et al., 2000). Addition of GnRH to the 14-19 d MGA-PG protocol further improved estrus response, estrus synchrony, and ovulation in beef heifers (Wood et al., 2001). Recently, GnRH was added to a short-term progestin-PG protocol (**7-11 Synch**) and effectively synchronized estrus and ovulation in postpartum beef cows (Kojima et al., 2000). The objective of this study was to identify estrus synchronization protocols that offer potential for use in fixed-time AI programs for replacement beef heifers.

Materials and Methods

Three MGA-based protocols were compared in yearling Angus heifers (n = 345) at the Circle A Ranch Heifer Development Center, Lineville, IA. Heifers were assigned to one of three treatments by reproductive tract score (**RTS**: Anderson et al., 1991; Patterson et al., 2000), age, and weight 2 wk prior to the initiation of treatments (Table 1: n = 115/treatment). Treatments were: 1) MGA (0.5 mg·hd⁻¹·d⁻¹) for 14 d followed by PG (25 mg Lutalyse[®] Sterile Solution, Pharmacia Animal Health, Kalamazoo, MI) 19 d after MGA withdrawal (**MGA-PG**: Nix et al., 1998; Deutscher et al., 2000; Lamb et al., 2000); 2) addition of GnRH (100 µg Cystorelin[®], Merial, Athens, GA) on d 26 of the MGA-PG protocol (**MGA[®] Select**: Wood et al., 2001); and 3) MGA for 7 d, PG on the last day of MGA, GnRH 4 d after PG, and a second injection of PG 11 d after the last day of MGA (**7-11 Synch**: Kojima et al., 2000). Figure 1 illustrates treatment schedules for MGA-PG, MGA[®] Select, and 7-11 Synch. Heifers were monitored for signs of behavioral estrus by the HeatWatch[®] estrus detection system (DDx, Inc., Denver, CO) for 7 d beginning on the day PG was administered. AI was performed by a single technician 12 h after onset of estrus. A single AI sire was used in this study. The natural service breeding season began

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² Adapted from Journal of Animal Science 79(Suppl. 1):250(Abstract), 2001.

14 d after the last AI for 45 d. Pregnancy diagnosis was performed by ultrasonography (Aloka 500V: Aloka, Wallingford, CT) by a single technician at 35 d after the last AI and also at 40 d after the end of breeding season. Estrus response, synchronized conception rate, synchronized pregnancy rate, and final pregnancy rate were analyzed by Chi-square analysis. Synchrony of estrus was analyzed by ratio of variance (F-test) for mean time interval to onset of estrus.

Results

Estrus response did not differ ($P > 0.10$) among treatments. Estrus synchrony was greater ($P < 0.05$) for 7-11 Synch treated heifers (331.9) than for MGA-PG (667.1) or MGA[®] Select treated heifers (539.3; Figure 2 and Table 2). Synchronized conception rate and synchronized pregnancy rate were greater ($P < 0.05$) for MGA-PG (63 % and 54 %) than MGA[®] Select (45 % and 39 %) or 7-11 Synch (47 % and 37 %) treated heifers (Table 3). There was an effect of reproductive maturity/cycling status of heifers, indicated by RTS, on estrus response, synchronized conception rate, and synchronized pregnancy rate regardless of treatment. Estrus response (93 % and 81 %), synchronized conception rate (66 % and 46 %), and synchronized pregnancy rate (62 % and 37 %) were all greater ($P < 0.01$) among cycling compared to non-cycling heifers.

Summary

Estrus response, synchronized conception rate, and synchronized pregnancy rate were all lower than previous trials (Wood et al., 2000, 2001). Pregnancy rates were high among heifers assigned to the MGA-PG treatment, however, the variance for interval to estrus was greater. The variance for interval to estrus was lowest among the 7-11 Synch treated-heifers; indicating better estrus synchrony. Reproductive maturity/cycling status significantly influenced response to synchronization treatment and subsequent conception and pregnancy rate in yearling beef heifers.

Table 1. Age and weight of heifers at the 1st day of MGA feeding.

Treatment	No. of heifers	Age (day)	Weight (kg)
MGA-PG	115	405 ± 1.7 ^a	286 ± 2.0
MGA [®] Select	115	404 ± 1.5 ^a	286 ± 1.9
7-11 Synch	115	422 ± 1.4 ^{b*}	286 ± 1.8

^{a, b} Numbers with different superscript within column differ ($P < 0.01$).

* Initiation of MGA feeding was 15 days later in 7-11 Synch group.

Table 2. Estrus response, interval to estrus, and variance for interval to estrus (estrus synchrony).

Treatment	Estrus response	Interval to estrus (h)	Variance
MGA-PG	100/115 (87 %)	54.7 ± 2.6	667.1 ^a
MGA [®] Select	100/115 (87 %)	52.0 ± 2.4	593.3 ^a
7-11 Synch	91/115 (79 %)	52.1 ± 1.9	334.9 ^b

^{a, b} Numbers with different superscript within column differ ($P < 0.01$).

Table 3. Synchronized conception, synchronized pregnancy, and final pregnancy rates.

Treatment	Synchronized conception	Synchronized pregnancy	Final pregnancy
MGA-PG	61/100 (61 %) ^a	61/115 (53 %) ^c	96/115 (83 %)
MGA [®] Select	46/100 (46 %) ^b	46/115 (40 %) ^d	101/115 (88 %)
7-11 Synch	44/91 (48 %) ^b	44/115 (38 %) ^d	96/115 (83 %)

^{a, b} Numbers with different superscript within column differ (P < 0.08).

^{c, d} Numbers with different superscript within column differ (P < 0.05).

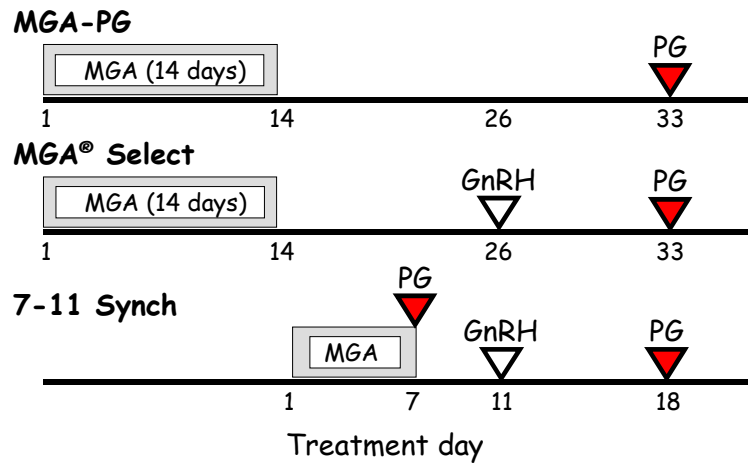


Figure 1. Illustration of the treatment schedule for MGA-PG, MGA[®] Select, and 7-11 Synch. MGA = melengestrol acetate, and PG = prostaglandin F_{2α}.

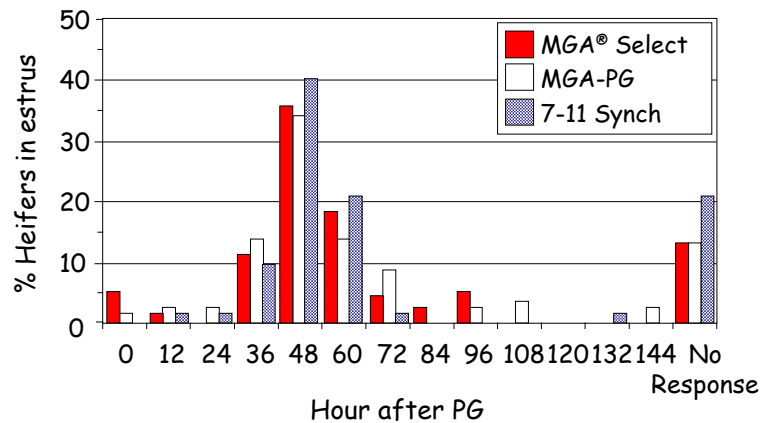


Figure 2. Distribution of estrus response in heifers treated with MGA-PG, MGA[®] Select, and 7-11 Synch (Hour 0 = time of prostaglandin F_{2α} [PG] administration).

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NOTES
