Evaluation of two progestogen-based estrous synchronization protocols in yearling heifers of *Bos indicus × Bos taurus* breeding

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Abstract

Yearling *Bos indicus × Bos taurus* heifers (n = 410) from three locations, were synchronized with either the Select Synch/CIDR+timed-AI (SSC+TAI) or 7-11+timed-AI (7-11+TAI) treatments. On Day 0 of the experiment, within each location, heifers were equally distributed to treatments by reproductive tract score (RTS; Scale 1–5: 1 = immature, 5 = estrous cycling) and body condition score. The 7-11+TAI treatment consisted of melengestrol acetate (0.5 mg/head/d) from Days 0 to 7, with PGF$_2$-$\alpha$ (25 mg im) on Day 7, GnRH (100 µg im) on Day 11, and PGF$_2$-$\alpha$ (25 mg im) on Day 18. The SSC+TAI heifers received the same carrier supplement (without MGA) from Days 0 to 7, and on Day 11 they were given 100 µg GnRH and an intravaginal CIDR (containing 1.38 g progesterone). The CIDR were removed on Day 18, concurrent with 25 mg PGF$_2$-$\alpha$ im For both treatments, estrus was visually detected for 1 h twice daily (0700 and 1600 h) for 72 h after PGF$_2$-$\alpha$, with AI done 6 to 12 h after a detected estrus. Non-responders were timed-AI and received GnRH (100 µg im) 72 to 76 h post PGF$_2$-$\alpha$. The 7-11+TAI heifers had a greater (P < 0.05) estrous response (55.2 vs 41.9%), conception rate (47.0 vs 31.3%), and synchronized pregnancy rate (33.5 vs 24.8%) compared to SSC+TAI heifers, respectively. Heifers exhibiting estrus at 60 h (61.7%) had a greater (P < 0.05) conception rate compared to heifers that exhibited estrus at 36 (35.3%), 48 (31.6%), and 72 h (36.2%), which were similar (P > 0.05) to each other. As RTS increased from 2 to ≥ 3, estrous response, conception rate, synchronized pregnancy rate, and 30 d pregnancy rate all increased (P < 0.05), irrespective of synchronization treatment. In conclusion, the 7–11+TAI treatment yielded greater synchronized pregnancy rates compared to SSC+TAI treatment in yearling *Bos indicus × Bos taurus* heifers. © 2011 Elsevier Inc. All rights reserved.

Keywords: Artificial insemination; Beef heifers; CIDR; Estrous synchronization; MGA

1. Introduction

Estrous synchronization is a reproductive management tool that allows for an increased number of cattle displaying estrus over a 3 to 5 d period, thereby allowing for either minimal estrus detection or timed-AI (without estrus detection). The Select Synch protocol, commonly used to synchronize estrus in *Bos taurus* cattle, utilizes GnRH with prostaglandin F$_{2\alpha}$ (PGF$_{2\alpha}$) 7 d later [1,2], followed by 5 d of estrus detection. However, premature expression of estrus prior to PGF$_2$-$\alpha$ commonly occurs, resulting in the need for additional estrus detection [3]; this can be eliminated by giving exogenous progestogen between GnRH and PGF$_2$-$\alpha$ [4,5]. The addition of a progestosterone insert, e.g., the Eazi-Breed™ CIDR® (CIDR) to the Select Synch protocol, combined with estrus detection for 72 h after CIDR removal and timed-AI + GnRH for non-responders, also known as the Select Synch/CIDR+timed-AI protocol, is an effective estrus
synchronization protocol in yearling Bos taurus heifers [6]. However, the effectiveness of this protocol in yearling Bos indicus × Bos taurus heifers has not been thoroughly evaluated.

The 7–11 synchronization protocol consists of a 7 d melengestrol acetate (MGA) treatment, with PGF$_{2\alpha}$ on the last day of MGA, followed by GnRH 4 d later. Seven days after GnRH, PGF$_{2\alpha}$ is given to synchronize estrus [7]. The 7–11 protocol is effective in Bos taurus cattle [7,8], but there are apparently no reports regarding the effectiveness of the 7–11 protocol in yearling heifers of Bos indicus × Bos taurus breeding. The rationale for this protocol is that GnRH 4 d after MGA + PGF$_{2\alpha}$ ovulates the majority of large follicles, which results in synchronous follicle development when PGF$_{2\alpha}$ is given 7 d later. When this protocol was recently used to synchronize suckled postpartum Brangus and Angus cows (estrous cycling and anestrous), 94.4% ovulated in response to GnRH treatment [9]. The resulting 5-d estrous response, conception, and synchronized pregnancy rates were similar between Angus and Brangus cows. Since GnRH effectively ovulates and synchronizes follicles when administered 4 d after a short-term (7 d) progestogen treatment in Brangus cows, the 7–11 protocol could be effective in yearling heifers of Bos indicus × Bos taurus breeding.

The objective of the present experiment was to evaluate the effectiveness of the 7–11 + timed-AI and Select Synch/CIDR+timed-AI synchronization protocols in yearling heifers of Bos indicus × Bos taurus breeding.

2. Materials and methods

2.1. Animals

The experiment was conducted at three locations in North Central Florida from January to March. Yearling (12–15 mo) Bos indicus × Bos taurus heifers (n = 410) were used. The proportion of Bos indicus breeding ranged from approximately 25–50%, with the remainder being Bos taurus breeding (Table 1).

2.2. Experimental design

At the start of the experiment (Day 0) heifers were evaluated for and equally distributed by reproductive tract score (RTS) [10] and body condition score (BCS; Scale 1–9; 1 = severely emaciated, 5 = moderate, 9 = very obese) [11] to one of two progestogen-based synchronization protocols, including the 7–11 + timed-AI (7–11 + TAI) and Select Synch/CIDR + timed-AI (SSC + TAI) protocols (Fig. 1). A single technician with several years experience of conducting RTS performed the RTS exams at all locations. The 7–11 + TAI heifers received MGA (MGA®200 premix, Pfizer Animal Health, New York, NY, USA) in a carrier supplement fed at a rate of 0.9 kg/head/d, to deliver 0.5 mg MGA/head/d from Days 0 to 7 of the experiment. Heifers were given PGF$_{2\alpha}$ (25 mg im; Lutalyse® Sterile Solution, Pfizer Animal Health, New York, NY, USA) on the last day of MGA. On Day 11, heifers received GnRH (100 μg im; Cystorelin®, Merial, Duluth, GA, USA), followed by PGF$_{2\alpha}$ (25 mg im; Lutalyse® Sterile Solution) on Day 18. The SSC + TAI heifers received the same carrier supplement without MGA from Days 0 to 7. On Day 11, a CIDR (1.38 g progesterone; Eazi-Breed™ CIDR®, Pfizer Animal Health) was inserted concomitant with GnRH (100 μg im; Cystorelin®). The CIDR were removed on Day 18 concurrent with PGF$_{2\alpha}$ (25 mg im; Lutalyse® Sterile Solution). The MGA supplement and the supplement without MGA were dispensed into feed bunks to promote uniform consumption.

![Fig. 1. Experimental design evaluating the effects of two progestogen-based synchronization treatments in yearling Bos indicus × Bos taurus heifers.](image-url)
Heifers for both synchronization treatments received Estrovent™ patches (Rockway, Inc., Spring Valley, WI, USA) on Day 18 of the experiment to aid in estrus detection. Estrus was visually detected for 1 h twice daily (0700 and 1600 h) for 72 h after PGF$_{2\alpha}$, with AI done 6 to 12 h after detection of estrus. Non-responders were timed-AI and received GnRH (100 µg i.m.; Cystorelin®) 72 to 76 h post PGF$_{2\alpha}$. Estrus was defined as either a heifer standing to be mounted by another heifer, showed signs of visible mucous, and (or) had a half to fully activated estrous detection patch. A single AI technician within each location inseminated heifers using frozen-thawed semen from multiple sires. The AI sires were equally distributed across treatments and between heifers that either exhibited estrus and (or) were timed-AI. Natural service sires were placed with heifers 10 d after timed-AI. Using real-time B-mode ultrasonography (Aloka 500 V with a 5.0 MHz transducer, Corometrics Medical Systems, Wallingford, CT, USA), pregnancy diagnosis was conducted approximately 55 d after AI. Due to the 10 d period where no heifers were exposed to natural service sires, differences in fetal size were used to determine whether a pregnancy resulted from the synchronized AI breeding or natural service [12].

Estrous response was defined as the number of heifers displaying estrus for 3 d after PGF$_{2\alpha}$, divided by the total number of heifers treated. Conception rate was defined as the number of heifers that became pregnant to AI, divided by the number of heifers that displayed estrus and were AI. Timed-AI pregnancy rate was the number of heifers that failed to display estrus, were timed-AI, and became pregnant, divided by the total number of heifers that were timed-AI. Synchronized pregnancy rate was the number of heifers pregnant to AI divided by the total number of heifers treated. Thirty-day pregnancy rate was the number of heifers pregnant during the first 30 d of the breeding season, divided by the total number of heifers treated.

2.3. Statistics

Binomially distributed data including estrous response, conception rate, timed-AI pregnancy rate, synchronized pregnancy rate, and 30 d pregnancy rate were analyzed by logistic regression using the LOGISTIC procedure of SAS (SAS Inst. Inc., Cary, NC, USA). All models included synchronization treatment, location, BCS, and all appropriate interactions. Body condition was analyzed as a categorical variable and was grouped into three categories (≤ 4.5, 5.0, and ≥ 5.5). The effect of interval from PGF$_{2\alpha}$ to the onset of estrus (≤ 36, 48, 60, and 72 h) on conception rate was analyzed with synchronization treatment, location, BCS, and all appropriate interactions were included in the model. Because of a limited number of heifers exhibiting estrus between 0 and 36 h after PGF$_{2\alpha}$, intervals were combined into ≤ 36 h. The initial logistic regression model entered variables at $P \leq 0.20$ by a stepwise selection based on the Wald statistics criterion, and in the final model, all variables with $P > 0.10$ were removed. Variables were considered significant at $P \leq 0.05$. Variables that were significant were entered into a linear regression model using GENMOD procedure of SAS to calculate the adjusted odds ratios and 95% confidence intervals. Reproductive tract score was not included in the initial model due to confounding effects with BCS; therefore, a second model was conducted, evaluating the same binomial variables of estrous response, conception rate, timed-AI pregnancy rate, synchronized pregnancy rate, and 30 d pregnancy rate. The categorical variables including synchronization treatment, location, RTS, and all appropriate interactions. Reproductive tract score was evaluated as a categorical variable and was grouped into three categories (≤ 2, 3, and ≥ 4). The initial analysis indicated that all response variables were similar between RTS 4 and 5, so the two RTS categories were combined for the final analysis. The same statistical process as previously described was used to determine the final logistic regression model, as well as the linear regression model. Adjusted odds ratios and 95% confidence intervals are also reported. Odds ratios were reported in the tables and were used to calculate relative risk, and relative risk was reported in the results.

3. Results

3.1. Estrous response

An increased ($P < 0.05$) percentage of heifers expressed estrus during the 72 h following PGF$_{2\alpha}$ for the 7–11 + TAI compared to SSC+TAI treatment (Table 2). Estrous response was also affected ($P < 0.05$) by BCS. Heifers with a BCS ≤ 4.5 and 5.0 had a decreased ($P < 0.05$) estrous response compared to heifers with a BCS ≥ 5.5 (Table 3). The relative risk of heifers with a BCS ≤ 4.5 exhibiting estrus was 60% of heifers with a BCS ≥ 5.5, and heifers with a BCS 5.0 exhibiting estrus was 74% of heifers with a BCS ≥ 5.5. Estrous response was not affected ($P > 0.05$) by location, nor were there any significant interactions.
3.2. Conception rate

Conception rates were also affected (P < 0.05) by synchronization treatment. The risk of heifers being pregnant to an AI after an observed estrus was 1.5 times greater for the 7–11 TAI compared to SSC TAI heifers (Table 2). In addition, conception rate was also affected (P < 0.05) by the interval from PGF2α to the onset of estrus (Fig. 2); however, there was no (P > 0.05) treatment by interval from PGF2α to the onset of estrus effect on conception rate. Heifers exhibiting estrus at 60 h had an increased (P < 0.05) conception rate compared to heifers that had exhibited estrus at 36, 48, and 72 h (Fig. 2), which were similar (P > 0.05) to each other. Conception rates were not (P > 0.05) affected by BCS and location, nor were there any significant interactions.

3.3. Pregnancy rates

Timed-AI pregnancy rates were similar (P > 0.05) between the 7–11 TAI and SSC TAI treatments (Table 2) and there were no effects (P > 0.05) of BCS and location on timed-AI pregnancy rate, nor were there any significant interactions.

Synchronized pregnancy rates were affected (P < 0.05) by synchronization treatment. The risk of heifers treated with the 7–11 TAI becoming pregnant to the synchronized breeding was 1.4 times greater compared to the SSC TAI treatment (Table 2). Synchronized pregnancy rates were not affected (P > 0.05) by BCS and location, nor were there any significant interactions. Thirty-day pregnancy rates were similar (P > 0.05) between treatments (Table 2) and were not affected (P > 0.05) by BCS or location, nor were there any significant interactions.

3.4. Reproductive tract score effects

The effect of RTS on response to synchronization treatments is shown (Table 4). There were no treatment by RTS effects (P > 0.05), but RTS affected (P < 0.05) estrous response, conception rate, synchronized pregnancy rate, and 30 d pregnancy rate. It was noteworthy that heifers with a RTS ≥ 4 had a greater (P < 0.05) BCS (5.2 ± 0.02) compared to heifers with a RTS of 3 (5.0 ± 0.02) and ≤ 2 (4.7 ± 0.02), and those with a RTS 3 had a greater (P < 0.05) BCS compared to heifers with RTS ≤ 2. Heifers with a RTS ≥ 4 had a

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**Table 2**

Effectiveness of the 7-11+timed-AI (7-11+TAI) treatment compared to Select Sync/CIDR+timed-AI (SSC+TAI) synchronization treatment on reproductive performance in yearling Bos indicus × Bos taurus heifers.

<table>
<thead>
<tr>
<th>Variable</th>
<th>7–11+TAI</th>
<th>SSC+TAI</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estrous response (%)b</td>
<td>(55.2) 117/212</td>
<td>(41.9) 83/198</td>
<td>0.60</td>
<td>0.40–0.89</td>
<td>0.01</td>
</tr>
<tr>
<td>Conception rate (%)c</td>
<td>(47.0) 55/117</td>
<td>(31.3) 26/83</td>
<td>0.51</td>
<td>0.29–0.93</td>
<td>0.03</td>
</tr>
<tr>
<td>Timed-AI pregnancy rate (%)d</td>
<td>(16.8) 16/95</td>
<td>(20.0) 23/115</td>
<td>1.23</td>
<td>0.61–2.5</td>
<td>0.56</td>
</tr>
<tr>
<td>Synchronized pregnancy rate (%)e</td>
<td>(33.5) 71/212</td>
<td>(24.8) 49/198</td>
<td>0.65</td>
<td>0.43–1.00</td>
<td>0.05</td>
</tr>
<tr>
<td>Thirty-day pregnancy rate (%)f</td>
<td>(65.7) 138/210</td>
<td>(60.4) 119/197</td>
<td>0.80</td>
<td>0.53–1.19</td>
<td>0.27</td>
</tr>
</tbody>
</table>

* a Refer to Fig. 1 for details of treatments.

* b Percentage of heifers displaying estrus 72 h after PGF2α of the total treated.

* c Percentage of heifers pregnant to AI of the total that exhibited estrus and were AI.

* d Percentage of heifers that failed to display estrus, were timed-AI, and became pregnant of the total number of heifers that were timed-AI.

* e Percentage of heifers pregnant during the synchronized breeding of the total treated.

* f Percentage of heifers pregnant during the first 30 d of the breeding season of the total number of heifers treated.

* g 7–11+TAI treatment used as referent value.

* h 95% confidence interval.

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**Table 3**

Effect of body condition score (BCS) on estrous response in yearling Bos indicus × Bos taurus heifers.

<table>
<thead>
<tr>
<th>BCSa</th>
<th>Estrous response (%)b</th>
<th>Odds ratio</th>
<th>95% CIc</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 4.5</td>
<td>(37.5) 30/80</td>
<td>0.37</td>
<td>0.20–0.67</td>
<td>0.001</td>
</tr>
<tr>
<td>5.0</td>
<td>(46.4) 104/224</td>
<td>0.54</td>
<td>0.33–0.87</td>
<td>0.01</td>
</tr>
<tr>
<td>≥ 5.5</td>
<td>(62.3) 66/106</td>
<td>Referent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* a Body condition score (Scale 1–9): 1 = severely emaciated, 5 = moderate; 9 = very obese.

* b Percentage of heifers displaying estrus 72 h after PGF2α of the total treated.

* c 95% confidence interval.
2.0 times greater risk of exhibiting estrus compared to heifers with a RTS \( \leq 2 \) and a 1.3 times greater risk of exhibiting estrus compared to heifers with a RTS \( \geq 4 \) (Table 4). For conception rate, heifers with RTS \( \geq 4 \) had a 6 times greater risk of being pregnant after exhibiting estrus and being AI compared to heifers with RTS \( \leq 2 \). Conception rates were similar (\( P > 0.05 \)) between heifers with a RTS 3 and \( \geq 4 \) (Table 4).

Timed-AI pregnancy rates tended (\( P = 0.10 \)) to be greater for heifers with a RTS \( \geq 4 \) compared to heifers with a RTS \( \leq 2 \) (Table 4). Synchronized pregnancy rates were similar (\( P < 0.05 \)) for heifers with RTS \( \geq 4 \) and 3. However, heifers with RTS \( \geq 4 \) had a 4 times greater risk of becoming pregnant to the synchronized breeding compared to heifers with RTS 2 (Table 4). Heifers with RTS \( \geq 4 \) had a 2.3 greater risk of being pregnant during the first 30 d of the breeding season compared to heifers with RTS \( \leq 2 \) and a 1.2 greater risk compared to heifers with a RTS 3 (Table 4).

### 4. Discussion

Estrous response was greater for the 7–11 + TAI compared to SSC + TAI heifers. The 3 d estrous responses for both treatments were similar in yearling \( Bos indicus \times Bos taurus \) heifers synchronized with a long term (14 d) MGA + PGF\(_{2\alpha}\) synchronization protocol [13]. However, estrous responses for both treatments seemed considerably less compared to studies in \( Bos taurus \) heifers synchronized with the SSC + TAI [6].

### Table 4

<table>
<thead>
<tr>
<th>Variable</th>
<th>RTS(^b)</th>
<th>Means</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estrous response (%)(^d)</td>
<td>( \leq 2 )</td>
<td>28.3</td>
<td>0.30</td>
<td>0.16–0.58</td>
<td>0.0004</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>44.1</td>
<td>0.60</td>
<td>0.39–0.94</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>( \geq 4 )</td>
<td>56.1</td>
<td>Referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conception rate (%)(^e)</td>
<td>( \leq 2 )</td>
<td>6.7</td>
<td>0.07</td>
<td>0.10–0.60</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>44.6</td>
<td>1.15</td>
<td>0.59–2.20</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>( \geq 4 )</td>
<td>42.6</td>
<td>Referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timed-AI pregnancy rate (%)(^f)</td>
<td>( \leq 2 )</td>
<td>7.9</td>
<td>0.34</td>
<td>0.09–1.24</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>22.5</td>
<td>1.22</td>
<td>0.57–2.58</td>
<td>0.61</td>
</tr>
<tr>
<td></td>
<td>( \geq 4 )</td>
<td>19.8</td>
<td>Referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synchronized pregnancy rate (%)(^g)</td>
<td>( \leq 2 )</td>
<td>7.6</td>
<td>0.17</td>
<td>0.06–0.48</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>32.3</td>
<td>0.97</td>
<td>0.61–1.55</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>( \geq 4 )</td>
<td>32.6</td>
<td>Referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thirty-day pregnancy rate (%)(^h)</td>
<td>( \leq 2 )</td>
<td>32.1</td>
<td>0.22</td>
<td>0.07–0.68</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>59.1</td>
<td>0.49</td>
<td>0.24–1.0</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>( \geq 4 )</td>
<td>72.6</td>
<td>Referent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Refer to Fig. 1 for details of treatments.

\(^b\) RTS (Scale 1–5): 1 = immature, 5 = estrous cycling.

\(^c\) 95% confidence interval.

\(^d\) Percentage of heifers displaying estrus 72 h after PGF\(_{2\alpha}\) of the total treated.

\(^e\) Percentage of heifers pregnant to AI of the total that exhibited estrus and were AI.

\(^f\) Percentage of heifers that failed to display estrus, were timed-AI, and became pregnant of the total number of heifers that were timed-AI.

\(^g\) Percentage of heifers pregnant during the synchronized breeding of the total treated.

\(^h\) Percentage of heifers pregnant during the first 30 d of the breeding season of the total number of heifers treated.
a short-term progestogen protocol [14], or a CIDR + PGF$_{2\alpha}$ protocol [15]. In all of the aforementioned studies, 3 d estrous responses were approximately 20 to 30% greater compared to those in the present study in yearling $Bos$ indicus $\times$ Bos taurus heifers. Perhaps the decreased estrous response was due to heifer genotype and puberal status at the start of the synchronization treatment. Patterson et al [14] reported that pubertal yearling $Bos$ indicus $\times$ Bos taurus heifers had a significant reduction in estrous response (22%) compared to contemporary Bos taurus heifers synchronized with a short-term progestogen treatment. Additionally, estrus can be difficult to detect in cattle of Bos indicus breeding, due to decreased expression and duration of estrus [16], and an increased incidence of silent estrus [17]. Regardless, utilization of the estrous detection patches should have assisted in identifying heifers not observed in standing estrus. Therefore, we inferred that estrous detection was probably not the primary factor responsible for the decreased estrous response. In the absence of blood samples, the estrous cycling status at the start of the synchronization treatment was unknown. $Bos$ indicus $\times$ Bos taurus and Bos taurus heifers that have attained puberty before the start of a CIDR + PGF$_{2\alpha}$ treatment [15] had significantly increased estrous responses compared to pre-pubertal heifers. Moreover, heifers of Bos indicus breeding are known to reach puberty at older ages compared to Bos taurus heifers [18,19], which could have contributed to a decreased number of heifers that were pubertal at the start of the treatments. Additionally, the effectiveness of the synchronization treatments to induce estrous cycles in the pre-pubertal heifers is unclear. Lucy et al [15] reported that a CIDR + PGF$_{2\alpha}$ treatment induced estrous cycles in prepubertal Bos indicus $\times$ Bos taurus and Bos taurus heifers over several locations, ranging from 40 to 100%.

There was a marked increase in conception rates for the 7–11 + TAI (47.0%) compared to the SSC + TAI treatment (31.3%). Thus, the 7–11 + TAI treatment may be more effective in synchronizing follicle development compared to the SSC + TAI treatment, resulting in better fertility. The 7–11 + TAI protocol is designed to maximize follicle synchrony at PGF$_{2\alpha}$ treatment [7]. In contrast, administration of GnRH at the initiation of the SSC + TAI protocol probably is not as effective at ovulating and synchronizing follicle development, since animals are at various stages of follicle development at CIDR insertion, and GnRH will ovulate fewer follicles [20]. Consequently, there is the probability of an increased population of non-ovulated follicles that have extended durations of dominance at CIDR removal, resulting in ovulation of aged oocytes, with decreased fertility [21]. Follicles with prolonged dominance under the influence of exogenous progesterone had significantly decreased pregnancy rates compared to ovulation of follicles with normal duration of dominance [22,23]. Austin et al [24] reported that restricting the duration of dominance of a pre-ovulatory follicle to 4 d consistently yielded pregnancy rates > 70% in estrous cycling beef heifers. Furthermore, Bridges et al [25] reported that reducing the duration of a CIDR treatment from 7 to 5 d in postpartum Bos taurus beef cows significantly increased timed-AI pregnancy rates of a Co-Synch protocol. They attributed the increased fertility to a decreased duration of dominance of follicles induced to ovulate after CIDR removal.

Conception rates for the 7–11 + TAI treatment were similar to a report by Bridges et al [13] in peripubertal yearling heifers of Bos indicus $\times$ Bos taurus breeding synchronized with a long-term 14 d MGA + PGF$_{2\alpha}$ protocol. In contrast, conception rate for the SSC + TAI treatment was approximately 20% less compared to the Bridges et al [13] study. Moreover, conception rates for both treatments seemed considerably less compared to Bos taurus heifers synchronized with variations of the CIDR + PGF$_{2\alpha}$ protocols, where conception rates ranged from 60 to 80% [6,15]. The conception rate for the 7–11 + TAI heifers (47%) were similar to a report by Patterson et al [14] in estrous cycling Bos indicus $\times$ Bos taurus heifers synchronized with either a short term progestogen treatment or unsynchronized controls. Additionally, Patterson et al [14] reported a breed by energy level interaction on conception rates in estrous cycling Bos indicus $\times$ Bos taurus heifers, but not similarly treated Bos taurus heifers. They observed a 30% increase in fertility of the Bos indicus $\times$ Bos taurus heifers that were on an increasing plane of nutrition at breeding, compared to Bos indicus $\times$ Bos taurus heifers on a low plane of nutrition. In several studies with synchronized Bos taurus heifers, fertility to an observed estrus and AI were similar between pre-pubertal and pubertal heifers [6,15]. Perhaps the level of nutrition was not adequate enough to enhance the fertility of the Bos indicus $\times$ Bos taurus heifers in the present study. Body condition had no effect on conception rates across the 7–11 + TAI or SSC + TAI treatments. Although BCS can be used as an indicator of both pubertal status and nutrition level, a single record taken at the start of the synchronization treatment, which was 21 d before the start of the breeding period, was probably not an accurate indicator of
whether any significant changes in the plane of nutrition occurred in the weeks preceding the onset of treatment. Therefore, it is not clear what if any effects plane of nutrition and (or) estrous cycling status at the start of treatment had on conception rates.

Timed-AI pregnancy rates were similar between the 7–11 + TAI and SSC + TAI treatments, but they were nearly half the values observed for Bos taurus heifers synchronized with the SSC + TAI protocol [6]. It should be noted that there was an effect of interval from PGF$_{2\alpha}$ to the onset of estrus on conception rate; heifers that exhibited estrus at 60 h after PGF$_{2\alpha}$ had conception rates that were nearly twice that of heifers that exhibited estrus < 36, 48, and 72 h. Therefore, the timing of the timed-AI needs to be re-evaluated; perhaps it should be conducted 60 h after PGF$_{2\alpha}$ rather than 72 h. However, the primary reason that the timed-AI pregnancy rates were so low is probably due to the limited number of heifers that were puberal at the start of the experiment. Furthermore, neither synchronization treatment probably induced estrous cycles in a significant number of prepuberal heifers. This was supported by the fact that only 51% of the heifers with a RTS ≤ 3 (n = 180) became pregnant in the first 30 d of the breeding season, compared to 73% of the heifers with a RTS ≥ 4 (n = 230).

The 7–11 + TAI treatment had a greater synchronized pregnancy rate compared to the SSC + TAI protocol. The synchronized pregnancy rates of the 7–11 + TAI (33.5%) heifers seemed similar to those reported by Bridges et al [13] in yearling Bos indicus × Bos taurus heifers synchronized with the 14 d MGA + PGF$_{2\alpha}$ treatment (34.5%) with a single PGF$_{2\alpha}$ treatment. Bridges et al [13] significantly improved the synchronized pregnancy rate by 9% with the addition of a PGF$_{2\alpha}$ treatment 24 h after the first PGF$_{2\alpha}$ treatment, which enhanced PGF$_{2\alpha}$ induced luteolysis, resulting in greater estrous response and timed-AI pregnancy rates. It should be noted that heifers in the Bridges et al [13] study were in later stages of the estrous cycle (Days 12–15), where PGF$_{2\alpha}$ is more effective in initiating luteolysis in Bos taurus [26,27] and Bos indicus cattle [28,29]. Incomplete luteolysis can lead to decreased estrous response, which directly affects synchronized pregnancy rates. Whether incomplete luteolysis occurred in both synchronization treatments is unknown, as blood samples were not taken at PGF$_{2\alpha}$ administration and during the days after PGF$_{2\alpha}$ to confirm if luteolysis occurred. The synchronized pregnancy rates for both treatments seemed considerably less compared to 58% in Bos taurus heifers synchronized with SSC + TAI protocol [6], 68% in Bos taurus heifers synchronized with 7–11 protocol [6], and 43% in Bos taurus and Bos indicus × Bos taurus heifers synchronized with a CIDR + PGF$_{2\alpha}$ protocol [15]. The primary reasons for the decreased synchronized pregnancy rates were a combination of a decreased estrous response, conception rate, and timed-AI pregnancy rate for the 7–11 + TAI and SSC + TAI treatments. All three of the response variables were most likely influenced by pubertal status at the start of the synchronization treatment.

Since RTS [10] can be an indirect indicator of pubertal status in yearling heifers, it was performed at the start of the experiment to provide an estimate of pubertal status. Although RTS had an effect on estrous response, conception rate, synchronized pregnancy rate, and 30 d pregnancy rate regardless of synchronization treatment, the magnitude in differences between response variables across the different RTS categories was less than anticipated. Patterson et al [30] reported significant increases in estrous response in Bos taurus heifers as RTS increased from a 1 to 3 and reaching a plateau for RTS 4 and 5, which was similar to the present observations. It was not unexpected that the combined conception rate for the RTS 1 and 2 was only 6.7%, which was significantly less compared to heifers with RTS ≥ 3. However, what was unforeseen was that conception rates did not increase as RTS increased from a 3 to either a 4 or 5, as previously reported in synchronized yearling Bos taurus heifers [30]. Additionally, it was unexpected that synchronized pregnancy rates were similar for heifers with a RTS of 3 compared to RTS of 4 and 5, as synchronized pregnancy rates typically increase as RTS increased from a 3 to a RTS of 4 or 5 [31]. However, 30 d pregnancy rates tended to be greater for heifers with a RTS of 4 and 5 compared to RTS of 3, which were all greater compared to RTS 1 and 2. Therefore, we inferred that RTS may not be an effective indictor of pubertal status in yearling heifers of Bos indicus × Bos taurus breeding, as is the case in estimating pubertal status in yearling Bos taurus heifers. Additional research needs to be conducted to determine if RTS can be used as an accurate predictor of pubertal status, based on both blood progesterone concentrations and transrectal ultrasonographic examinations to confirm the activity and presence of luteal tissue in yearling heifers of Bos indicus × Bos taurus breeding.

In summary, the 7–11 + TAI treatment provided increased estrous response, conception rates, and synchronized pregnancy rates compared to the SSC + TAI treatment. Synchronization treatments had similar timed-AI pregnancy rates. Estrous response was di-
rectly affected by BCS at start of synchronization, but BCS had no significant effect on any of the other response variables. Although, RTS had significant effects on estrous response, conception rate, synchronized pregnancy rate and 30 d pregnancy rate, the difference was primarily between heifers with RTS of 1 and 2 compared to heifers with an RTS of 3, 4, or 5. The 7–11 + timed-AI synchronization treatment resulted in more yearling heifers of Bos taurus × Bos indicus breeding pregnant to the synchronized breeding compared to the Select Synch/CIDR+timed-AI protocol; however, the synchronized pregnancy rates seemed less compared to previous reports for Bos taurus heifers. The role that RTS and BCS play as predictors of pubertal status in Bos indicus × Bos taurus heifers when synchronizing remains unclear. Furthermore, careful considerations must be made for timing of the initiation of synchronization treatments in heifers of Bos taurus × Bos indicus breeding, which are known to attain puberty at older ages.

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References


