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Impact of thermal stress on the efficiency of ovulation synchronization protocols in Holstein cows

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ABSTRACT

The objective of this study was to evaluate the impact of thermal stress on the efficiency of three different protocols to synchronize time of ovulation in purebred Holstein cows under subtropical Egyptian conditions. The influence of temperature humidity index (THI) on the conception, pregnancy, embryonic loss and early abortion rates were investigated. Conception and pregnancy rates using the CIDRsynch and Presynch (37.5% and 33.9%; 29.5 and 29. 6%, respectively) were significantly greater than that for cows expressing spontaneous estrus (SE) and with use of the Ovsynch (28.5% and 24.3%; 21.6% and 24.6%, respectively) treatment regimen. Conception and pregnancy rates using the Ovsynch protocol were significantly decreased from 31.6% and 26.3% at the lesser THI to 11.5% and 9.9%, respectively than at the greater THI [crude odds ratio (COR) = 0.28 and 0.32; $P = 0.001$ and 0.004, respectively]. However, conception (P/AI at 28 days) and pregnancy (P/AI at 75 days) rates using the Presynch protocol were significantly reduced at either the lesser or greater THI (COR = 0.47 and 0.42; 0.48 and 0.34, respectively). Embryonic loss rate with the Presynch group was significantly increased from 11.5% at the lesser THI to 22.2% at the greater THI (COR = 2.28; $P = 0.039$). In contrast, conception, pregnancy and embryonic loss rates did not differ significantly ($P > 0.05$) with the CIDRsynch protocol at the different THI. Results from the present study indicate that use of the CIDRsynch protocol may provide consistent and satisfactory conception and pregnancy rates in Holstein cows under subtropical environmental conditions.

1. Introduction

Fertility in dairy cows is well-defined as the ability of the animal to conceive and maintain pregnancy if inseminated at the appropriate time relative to ovulation (Darwash et al., 1997). Poor estrous detection and embryonic or fetal losses are among the leading causes for poor reproductive performance (Senger, 1994; Sturman et al., 2000). During the postpartum period, about 50% of standing periods of estrus are undetected (Mialot et al., 1999). This failure in estrous detection can increase the average interval between successive inseminations to about 40–50 days and reduces both reproductive efficiency and profitability (Stevenson et al., 1983). Programs aimed at regulating the estrous cycle focus on allowing the precise detection of cows in estrus (Nebel and Jobst, 1998). The recently developed time-of-ovulation synchronization protocols are extensively utilized for the timed artificial insemination (TAI) to improve reproductive performance in lactating dairy cows

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(Pursley et al., 1995). The concept of synchronization of time of ovulation involves termination of the existing wave of follicular development and induction of a newly synchronized wave of follicle development. This is followed by induced regression of the corpus luteum at an appropriate time to allow for synchronized timing of the follicle maturation and ovulation from the dominant follicle. Induced cessation of the wave of ovarian follicular development can be achieved by treating the animal with GnRH or estradiol plus progesterone. With the GnRH based protocols, administration of the GnRH induces ovulation or regression of the dominant follicle depending on developmental stage (Wiltbank et al., 2011).

The most prevalent GnRH based protocol for synchronizing the time of ovulation extensively applied in dairy farms is the Ovsynch treatment regimen (Pursley et al., 1995). There have been numerous investigations regarding the incorporation of the progesterone treatment into the Ovsynch protocol through insertion of a controlled internal drug-release (CIDR) between the Day 0 and the Day 7 of the Ovsynch treatment regimen (Mendonçaa et al., 2012; Colazo et al., 2013). The influence of incorporating the CIDR into the Ovsynch protocol on conception rate has not been consistent across studies. With some trials, there was no improvement in response in either heifers or cows (Galvão et al., 2004; Mendonçaa et al., 2012). In other studies, insertion of the CIDR improved the conception rate in cows not previously observed in estrus or without a corpus luteum at the beginning of the treatment protocol (Stevenson et al., 2008; Chebel et al., 2010). Use of two PGF2α injections administered 14 days apart comprises an economically inexpensive and practical system for estrous synchronization and has been used extensively in lactating dairy cows (Ferguson and Galligan, 1993). Use of such a program is expected to synchronize the stage of the estrous cycle among a large proportion of estrous cyclic cows to express estrus within a 7-day period. Thus, use of two PGF2α injections to pre-synchronize stage of the estrous cycle in cows to initiate the TAI protocol at the targeted early luteal phase should increase subsequent pregnancy rates.

Heat stress severely reduces pregnancy rates in dairy cows. Conception rates have been decreased from 40% to 50% during months when ambient temperatures are decreased to less than 10% during the months of the year when ambient temperatures are greater (Badinga et al., 1985). In addition to effects on embryonic mortality (Putney et al., 1989), heat stress decreases the intensity and duration of behavioral estrus (Abilay et al., 1975) so that a smaller proportion of cows are detected in estrus under heat stress conditions (Thatcher and Collier, 1986). The majority of strategies to reduce the effects of heat stress on reproduction have been to change the environment of the cow through the use of shade, fans, or evaporative cooling (Bucklin et al., 1991). However, these approaches have not allowed for overcoming the problems related to heat stress. For example, the interval from parturition to conception during summer was 24–67 days longer than during the winter even though barns during summer were supplied with evaporative coolers (King et al., 1988). Consequently, additional reproductive strategies are required to reduce the deleterious effects of heat stress. One such strategy might be the use of TAI protocols. These protocols include timed injections of GnRH and PGF2α to control synchronization of time-of-ovulation that is accurate enough to achieve acceptable pregnancy rates (Pursley et al., 1995). The use of TAI has advantages for inducing early postpartum reproductive activity, reducing the requirements for the detection of estrus, and saving labor through the use of programmed times for AI. Timed AI might have the greatest effectiveness during heat stress because of the increased problems associated with the detection of estrus. The present study, to the best of our knowledge, is one of a few recent trials that have been conducted to investigate the effect of subtropical conditions on the efficacy of TAI protocols. The objectives of the present study were to evaluate the efficiency of three different protocols to synchronize time of ovulation in purebred Holstein cows under subtropical Egyptian conditions.

2. Materials and methods

2.1. Animals and management

This study was conducted at EXPANDED herd, Ismailia road, Cairo, Egypt. The herd consisted mainly of 1680 purebred Holstein cows. All cows were housed in a free stall barn, were milked three times daily with milk yields recorded at each milking and had pedometers attached to facilitate detection of estrus. The total mixed ration (TMR) was provided twice daily for all cows. The dietary ration was mixed daily and modified according to the milk production and body condition score of the cows. The TMR was formulated to meet the standard requirements of energy, protein, minerals and vitamins. The TMR was sampled monthly and analyzed by wet chemistry methods. The primary analysis of TMR includes crude protein (16.91%), neutral detergent fiber (24.83%) and net energy for lactation (MJ/kg = 7.36). The diets during the non-lactating period were formulated to meet the nutrient requirements established by NRC. The reproductive data (insemination, reproductive problems, etc.) were recorded and tracked using a commercial on-farm computer software programs (AfiFarm version 4.1).

2.2. Reproductive performance and TAI protocols

All cows were under close veterinary supervision. Cows experiencing an abnormal puerperium period, such as calving difficulty, twinning, ovarian cysts, retained placenta, primary metritis (confirmed during the first or second week post-partum), or ketonuria were excluded from the study. The cows were scored for body condition using a five-point scale: 1 = thin to 5 = fat (Edmonson et al., 1989). Cows assigned scores of 2.4–3.5 (2.8 ± 0.4) were considered to be in an acceptable body condition. The mean number of days from calving to first AI was 53.5 ± 6 days (range 44–74 days). Mean daily milk production on Day 50 postpartum was 35.7 ± 6.7 kg, ranging from 28 to 46 kg. Efforts were made to decrease variation in the nutritional and general health aspects of the animals, so that observed impacts of the treatment and THI could not be attributed