SYNCHRONIZATION OF ESTRUS IN CATTLE

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INTRODUCTION

The purpose of this article is to briefly review synchronization of estrus in cattle, with an emphasis on recent developments. Throughout this review, the day of ovulation is defined as Day 0 (therefore, the day of estrus is approximately Day -1).

OVARIAN FUNCTION

Follicle growth occurs in waves, the simultaneous development of several follicles (Adams, 1994; Kastelic, 1994). Most cows have either 2 or 3 waves during an estrous cycle. One follicle per wave becomes dominant and grows for several days (maximum diameter, approximately 1.5 cm) and suppresses growth of the remaining follicles in the wave (diameter usually < 1.0 cm). The first wave of the cycle usually starts around Day 0, grows for about 6 days, reaches a plateau, and then begins to regress a few days after a new wave starts (Day 9 or 10). In a three-wave cycle, the dominant follicle of the second wave also grows for a few days but ultimately regresses, with emergence of the third wave around Day 17. Late in the cycle, the dominant follicle (of the second or third wave) does not reach a plateau, but continues growing and ovulates. A corpus luteum (CL) forms at the site of ovulation. In pregnant cattle, the CL is maintained until just prior to parturition, but in nonpregnant cattle, release of prostaglandin F_{2a} (PGF) from the uterus (approximately Day 17) causes the CL to regress.

Prostaglandin

Synthetic PGF (and its analogues) are commonly used to synchronize estrus (Larson and Ball, 1992; Odde, 1990). Treatment with PGF will cause regression of a responsive CL; responsiveness begins as early as Day 5, increases to about Day 12 and then plateaus. By Day 17 the CL may be undergoing spontaneous regression induced by endogenous PGF. The viable dominant follicle present at the time of CL regression grows and ovulates (Kastelic et al., 1990; Kastelic and Ginther, 1991). With PGF treatment on Day 5, the dominant follicle of Wave 1 is still growing (interval from treatment to ovulation, 3 days). With treatment on Day 12, the dominant follicle of Wave 2 is early in its growth phase (treatment to ovulation averages 4.5 days). In cattle treated on Day 8, ovulation usually occurs from the dominant follicle of Wave 1 (4 days) but occasionally occurs from Wave 2, approximately 6 days after treatment. Due to this variation in interval from treatment to ovulation, fertility will usually be higher when cattle are bred after detection of estrus compared to breeding at a fixed time. The stage of the estrous cycle that PGF treatment is given also affects fertility; pregnancy rates are usually higher when cattle are treated with PGF after mid-cycle compared to early in the cycle (e.g., Day 14 versus Day 7).

There are many treatment regimens using PGF. Cattle that are cycling should have a responsive CL approximately 70% of the time. Rectal palpation and treatment of cattle with an apparently responsive CL should increase the proportion that respond; however, errors in detection of a responsive CL and failure to detect estrus result in about 75% of treated cattle being detected in estrus (Gaines, 1994). With natural service, all females can be given PGF 96 hours after the start of bull exposure; those bred prior to PGF treatment will not have a responsive CL (Whittier et al., 1991). Estrus detection and breeding for

5 days and then giving all nonbred cattle PGF works very well, but estrus detection and breeding are spread out over about 10 days. If less than 20% of cattle are detected in estrus by the fifth day, then either the cattle are not cycling and/or estrus detection is poor.

Some recent synchronization regimens have used analogues of gonadotropin releasing hormone (GnRH), followed by PGF 6 or 7 days later. Treatment with GnRH causes the dominant follicle to ovulate (if it is in the growing or early static phase) or to undergo atresia (if it is no longer viable), with emergence of a new follicular wave within 2 or 3 days after GnRH treatment (Pursley et al., 1995; Kastelic and Mapletoft, 1997). Estrus will be detected in a minority of cattle in the interval between GnRH and PGF; however, 60 to 70% of the cattle will be detected in estrus within 4 days after PGF treatment (Twagiramungu et al., 1995). The synchrony of estrus, and in particular ovulation, can be considerably increased by giving a second dose of GnRH, 36 to 48 hours after PGF. Timed insemination 18 to 24 hours after the second dose of GnRH has resulted in acceptable fertility, especially in cows, although fertility in heifers seems to be lower. In one study (Pursley et al., 1995), PGF was given 7 days after GnRH and a second dose of GnRH was given 36 hours (heifers) or 48 hours (cows) after PGF. A new follicular wave emerged after the first GnRH treatment in 18 of 24 heifers and in 20 of 20 cows. All 20 cows and 18 of 24 heifers ovulated a newly formed dominant follicle between 24 and 32 hours after the second GnRH treatment. All 20 cows were inseminated 24 hours after the second GnRH treatment and 10 became pregnant.

A common approach is two treatments with PGF 11 days apart, although fertility may be better if this interval is increased to 14 days (Folman et al., 1990). One protocol (Ferguson and Galligan, 1993; Fuhrmann, 1993) utilizes PGF injections at 14-day intervals.The voluntary waiting period (minimum interval from calving to first breeding) is determined and all postpartum cattle 3 to 17 days prior to the voluntary waiting period are injected with PGF. Fourteen days later, these cows are again treated with PGF and bred according to signs of estrus activity. Any cattle not detected in estrus will receive PGF on the next treatment day (14 days later) and will be bred upon signs of estrus or at 80 hours after treatment if estrus has not been detected by that time. Pregnancy diagnosis is conducted as early as possible, preferably at 14-day intervals, and nonpregnant cows are included in the group of cattle treated with PGF.

MELENGESTROL ACETATE (MGA)

Various progestins (progesterone-like compounds, including MGA) have been utilized for estrous synchronization (Larson and Ball, 1992; Odde, 1990; Patterson et al., 1989). Progestin treatment for more than 14 days will synchronize estrus, but fertility at the induced estrus will be reduced due to impairment of sperm transport, ovum fertilization and cleavage. These effects are transitory, and are no longer apparent at the next estrus.

The progestin most commonly used for estrous synchronization is MGA. The advantages of MGA include low cost (few cents per day), oral administration (usually mixed in grain) and extremely low toxicity. One regimen is to feed 0.5 mg MGA/head/day for 14 days, followed by treatment with PGF 17 days after cessation of MGA (Patterson et al., 1989). This regimen has been reported to give well-synchronized estrus with good fertility, especially in beef cattle in moderate (compared to fair or poor) body condition (Yelich et al., 1995a). Furthermore, separating suckling calves from their dams for 48 hours, starting 2 days after the last feeding of MGA, increased the percentage of 2- and 3-year old dams conceiving early in the breeding season (Yelich et al., 1995b). Most cattle will be in estrus a few days after cessation of MGA; however, they are not bred until the estrus following PGF treatment. Pregnancy rates will be optimized by detecting estrus and breeding accordingly. Insemination at 72 hours after PGF treatment has resulted in good fertility in some herds but not others (King et al., 1994; Larson et al., 1996). Therefore, one approach is to inseminate all cattle at 72 hours after PGF and then either detect estrus and inseminate from 72 to 120 hours or expose females to bulls starting at 96 hours (King et al., 1994).

A short-term regimen is to feed MGA (0.5 mg MGA/head/day) for 7 to 9 days with PGF given on the last day. However, cattle that lack a CL (due to anestrus or spontaneous CL regression during MGA treatment) develop a large ovarian follicle that elevates serum estradiol concentrations and reduces

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