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Introduction

The techniques of artificial insemination (AI) of fallow deer are remarkably efficient given the rather short history of intensive husbandry of the species and the recent initiation of research in this area of assisted reproduction (Asher *et al.* 1988; Mulley *et al.* 1988). However, the successful adoption of AI within the fallow deer industry has, in no small way, been possible only because of intensive and thorough investigations into our understanding of the natural reproductive cycle of both the male and female. In particular, the oestrous cycle of the fallow deer doe was well characterised (Asher 1985, Mulley 1989) before any attempts at its control were made. The purpose of this paper is to familiarise fallow deer farmers with the reproductive cycle of fallow does and techniques of its control (ie. synchronisation) relevant to AI.

(1) Oestrus (or "heat")

Oestrus refers to the limited period when a fallow doe is on heat (ie. is receptive to the sexual advances of the buck, and will stand for mating). Oestrus is a hormonally - induced condition that generally occurs only once every year (if the doe conceives to that mating) and usually only persists for between 15-25 minutes, being normally terminated by copulation (Asher 1986). In some instances, does may be re-mated about 6 hours after initial mating, but most does are mated only once per oestrus (Morrow 1992).

The first oestrus of the breeding season usually occurs between 15 April and 10 May in the southern hemisphere, with most does in a herd showing first heat within 12-14 days of each other (Asher 1985). Such natural within-herd synchrony (Figure 1) may be partly due to "social facilitation" effects, whereby social signals (eg. pheromones) induce physiological changes within herd members. Natural synchrony may also be partly due to the presence of "silent ovulations" occurring before first oestrus (Figure 2). Silent ovulations occur in the absence of any oestrous behaviour, and in this species are characterised as short (10-12 days) progesterone (luteal) cycles. Progesterone cycles are a necessary pre-requisite for the induction of true oestrous behaviour. Abbreviation of these cycles assists in the synchronisation of oestrus.

Oestrus and ovulation are intimately related, with the onset of oestrus preceeding ovulation by 24 hours. Such close alignment is not accidental and relates to the timing of sperm transport to the site of fertilisation after mating. This ensures optimum chances for fertilisation and conception to occur.

(2) Oestrous cycle

An "oestrous cycle" is defined as the time interval between two successive heats. Most fallow does conceive to their first oestrus of the breeding season and, therefore, do not exhibit oestrous cycles. However, in the absence of pregnancy, fallow does are able to exhibit continuous oestrous cycles for 3-6 months from the onset of first oestrus in April/May (Figure 3).

The oestrous cycle is characterised by luteal development within the ovary, whereby the

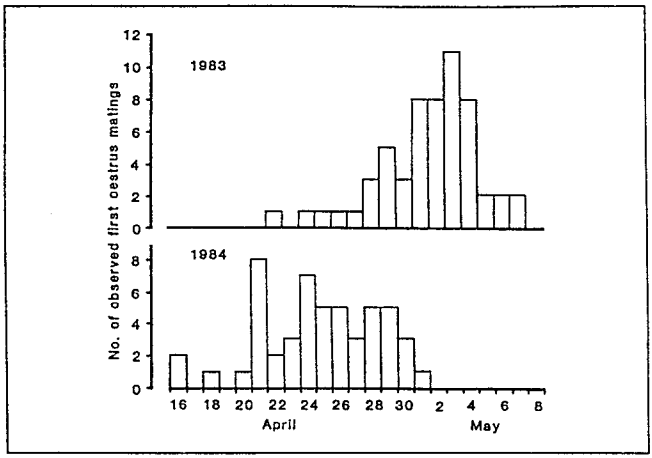

Figure 1: Occurrence of first oestrus of the breeding season in fallow deer does recorded on the Ruakura Agricultural Centre, NZ in 1983 and 1984 (Asher 1986).

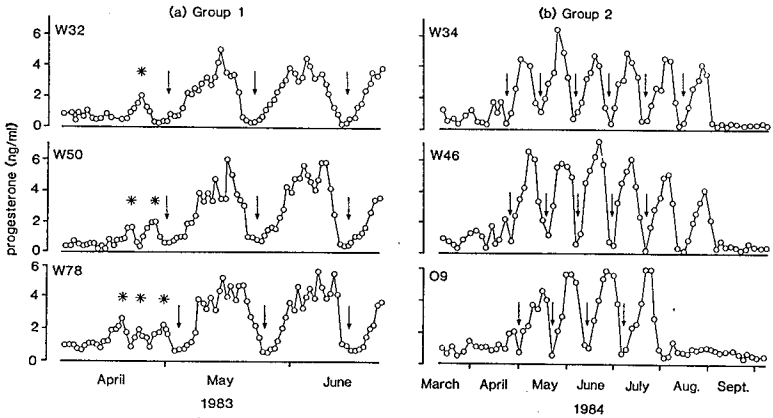

Figure 2: (a) Plasma progesterone profiles of three fallow does showing evidence of a variable number of silent ovulations (*) prior to first oestrus of the breeding season. Arrows indicate overt oestrus (Asher 1985).
(b) Plasma progesterone profiles of fallow does run continuosly with vasectomised bucks. Continuous oestrus cycles are clearly indicated by the cyclic fluctuations in progesterone levels between periods of oestrus (arrows) (Asher 1985).)

hormone progesterone is secreted maximally mid-cycle. Progesterone is secreted by a gland within the ovary, called the "corpus luteum" (CL). The CL develops following ovulation, and effectively blocks further ovulation through the secretion of progesterone. If does become pregnant, the CL remains intact for the remainder of pregnancy. However, if the doe fails to conceive, the CL is naturally destroyed (luteolysis) after a predetermined time interval (20-21 days), this leading to reinstigation of oestrus/ovulation.

The time interval between successive heats/ovulations is very uniform within a species, being 21-22 days for fallow deer (Asher 1985; Table 1). Such uniformity of oestrous cycle length is quite remarkable.

Table 1: Oestrous cycle lengths for fallow deer.

Cycle No.	No. of observations	Mean cycle length (days)	S.D.
1	33	21.0	0.64
2	33	22.0	0.66
3	33	22.9	0.97
4	28	23.0	1.11
5	12	23.5	1.45
6	3	25.7	1.53
Total	142	22.4	

(3) Oestrous detection

Natural oestrus can be detected with some degree of difficulty and a lot of effort by the farmer. Early studies have successfully used ram mating harnesses on bucks for the detection of heat in does. Mounting bucks leave red or blue crayon marks on the does' rump. However, crayons need to be replaced frequently (at least every two days), necessitating considerable handling at a tme of year when bucks are very aggressive towards other animals. Even if oestrous detection is successfully accomplished, natural within-herd synchrony would require an AI programme to span 10-12 days. For this reason, AI at natural oestrus is not practiced on fallow deer farms.

(4) Artificial oestrous synchronisation

AI programmes for fallow deer rely heavily on artificially synchronising oestrus and ovulation in order that all does may be inseminated within a period of 1-2 hours. Synchronisation allows placement of semen in the reproduction tract close to the time of ovulation, to increase the chances of fertilisation and conception.

Oestrous synchronisation in fallow does is not difficult and employs similar methods used for other livestock species. The proportion of does exhibiting induced oestrus and the degree of synchrony of oestrus are dependent on the time of year the treatments are administered. Generally, results are most consistent after the onset of the natural breeding season in autumn, although this can be modified by using melatonin implants to advance the onset of breeding activity.

A common method of oestrous synchronisation in domestic livestock is the use of progestagens (progesterone or its synthetic analogues) to over-ride natural oestrus/ovulation by simulating or prolonging an oestrous cycle. Progestagen - releasing devices are inserted intravaginally or subcutaneously for periods of 12-16 days. The sudden drop in blood progestagen levels that occurs upon removal of the device stimulates oestrus/ovulation. Therefore, synchrony is achieved by synchronous withdrawal of the devices.

While a wide range of progestagen-releasing devices has yet to be tested for efficacy of oestrous synchronisation in fallow deer, a number of studies have been conducted on the use of the intravaginal CIDR device ("Controlled Internal Drug Release"; NZ Dairy Board, Hamilton). The CIDR-type G device contains 0.3 g (9%) progesterone and is inserted intravaginally for 14 days in fallow does. The retention rate of CIDR devices is very high (98%-100%) and, during the period of insertion, they release sufficient progesterone to elevate blood concentrations to a level comparable to natural endogenous concentrations observed during the mid-oestrous cycle.

The use of pregnant mare serum gonadotrophin (PMSG) at or near CIDR device withdrawal, while common in other species (sheep, red deer), is contra-indicated for oestrous synchronisation in fallow deer. Even low doses of PMSG appear to reduce fertility and increase embryonic mortality in this species (Asher & Smith, 1987; Jabbour *et al.*, 1991).

Another form of oestrous synchronisation commonly used in cattle involves promoting the premature regression of the corpus luteum by injecting the powerful luteolytic hormone, prostaglandin F2α (or one of its analogues). This hormone is normally produced by the uterus of the non-pregnant female on days 19 to 21 of the oestrous cycle and terminates the

progesterone secretory activity of the corpus luteum. Exogenous prostaglandin will also terminate the secretory life of the corpus luteum if injected from about day 10 of the cycle. However, the corpus luteum appears to be insensitive (refractory) to prostaglandin before day 10. Therefore, the common treatment regimen for cattle is to administer two injections, 10-12 days apart. If a young corpus luteum is refractory at the first injection, it will certainly succumb to the second injection.

It must be stressed, however, that prostaglandin synchronisation regimes can only be effective during the breeding season as there is a requirement for the presence of active luteal tissue.

(5) Seasonal constraints in the use of the CIDR device.

While the type G-CIDR device has been the most effective device for oestrous synchronisation in fallow deer, there is one major constraint to its use. Insertion and removal of the device must be performed no earlier in the year than the natural onset of oestrous/ovulatory activity. Thus, CIDR device insertion should be performed no earlier than 15 April on most farms in the southern hemisphere. Treatment before this period will be associated with complete failure of an oestrus/ovulatory response; and is probably the major cause of some AI failures in the past (Morrow, 1992).

(6) Stimulatory effect of bucks

It has become common practice to run fallow does with vasectomised bucks during CIDR device insertion and for 10 days after AI. It is generally believed that buck presence is

important in stimulating does to ovulate following CIDR device withdrawal. However, recent studies suggest that buck presence may not be necessary if CIDR device treatment is performed well within the breeding season. Present recommendations are to at least run the synchronised does near to sexually active bucks, ensuring that fertile bucks have no chance of jumping into the doe paddock.

(7) Duration of CIDR device treatment

A standard treatment regimen of 14 days is recommended for oestrous synchronisation of fallow does with CIDR devices. However, durations of insertion of between 12 and 17 days are likely to also be effective. However, shorter intervals of treatment may be insufficient to over-ride the natural CL. If short treatment intervals are required (ie. 8-11 days), the additional injection of prostaglandin at, or just before, device removal will be necessary.

(8) Timing of AI

The average time to onset of oestrus following CIDR device removal is between 46-50 hours. Ovulation would be expected to occur 24 hours later (ie. 70-74 hours). The actual timing of artificial insemination depends on the type of insemination performed.

Laparoscopic intrauterine inseminations are normally performed very close to the predicted time of ovulation, at between 68-72 hours after CIDR device removal (Asher *et al.* 1992). Cervical inseminations are generally performed earlier; about 58-60 hours after device removal; because of the longer transport distance of spermatozoa (Jabbour *et al.* 1991). Both methods aim to have the semen in the uterus close to the time of ovulation.

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