Advancing the Breeding Season of Farmed Deer with Melatonin Implants

G W Asher
MAF Technology
Ruakura

Summary

- Regulin© implants provide a convenient means of delivering exogenous melatonin to farmed deer in order to advance reproductive seasonality. This will lead to better alignment of peak pasture production and the high energy demands of lactation.
- Initiation of Regulin© treatment to young hinds/does in late spring/early summer will advance the subsequent calving/fawning season by up to six to eight weeks, depending on the actual date of initiation. Concurrent treatment of males is necessary to ensure optimum conception rates.
- Reproductive advancement of Red deer stags alone will result in modest advancement in reproductive activity of hinds, resulting in two to three weeks advancement of calving.
- Treatment of pregnant hinds/does is contra-indicated due to suppression of the initiation of lactation at parturition. Furthermore, offspring born six to eight weeks early as a result of dam treatment may undergo precocious puberty, with negative effects on productivity.

Introduction

Seasonal patterns of growth and reproduction of Red deer and Fallow deer can impose some constraints on on-farm productivity in the pastoral environment. In particular, summer calving/fawning patterns are generally poorly aligned with pastoral feed production patterns throughout much of New Zealand. The fundamental tenet of advancing the birth season of farmed deer is to better align the high energy demands of lactation with the season of greatest feed availability and quality. This would allow for better utilisation of pasture resources and may increase dam lactational yields, resulting in greater calf/fawn growth rates, increased weaning weights, and earlier attainment of acceptable carcass weights.

The timing of the birth season of deer is strictly determined by the seasonality of conceptions. Any advancement of the birth season necessarily involves manipulation of the pattern of conceptions by advancement of oestrus/ovulation in females and spermatogenesis/rutting behaviour in males. A number of hormonal manipulation techniques have been used for these purposes in deer, as reviewed at the last Ruakura Deer Conference.

However, by far the most promising technique involves subcutaneous implantation of melatonin in the form of slow-release pellets (Regulin©; Shering Agrochemicals Ltd, Australia). The objective of this paper is to discuss the potential role of Regulin© in the New Zealand deer farming industry.

The Role of Melatonin

Melatonin is an indole-amine hormone secreted by the pineal gland during the hours of darkness. The annual pattern of secretion, therefore, is determined by regular changes in photoperiod (day:night ratio). Photoperiod, via melatonin secretion, acts as the main synchronising agent for reproductive and growth cycles of a large number of mammalian species. For Red deer and Fallow deer, this is manifested as a "short-day" effect, whereby decreases in daylength during autumn are associated with increased levels of melatonin secretion and progression into a reproductive state.

As melatonin is the principle messenger in relaying information on the prevalent photoperiod to other endocrine glands controlling the reproductive processes, much research in New Zealand and overseas has been directed at artificially modulating the melatonin signal in order to effect a change in reproductive seasonality of deer. Principally, this has involved supplementation of natural (endogenous) melatonin with synthetic (exogenous) melatonin to mimic the "short-day" effect during summer.

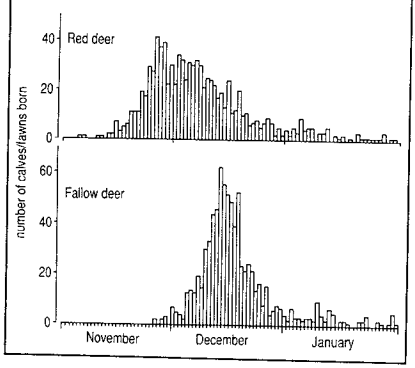
Early research adopted the method of daily oral supplementation, whereby melatonin-laced feed pellets were offered to individual deer, or groups of deer, three to four hours before the onset of darkness in summer. This resulted in a transient elevation of blood melatonin concentrations that augmented night-time endogenous secretion, thus simulating the "short-day" situation. While daily oral treatment of deer in summer clearly resulted in significant advancement of the breeding season, this method has little practical application on commercial deer farms. Oral delivery is wasteful of exogenous melatonin and requires a constant labour input for two to three months over summer. Besides which, some individual deer simply do not obtain a significant intake of feed pellets and, therefore, do not respond to treatment.

The development, during the 1980's, of small (<4.0 mm^3) coated-pellet subcutaneous implants, each containing only 18 mg synthetic melatonin (Regulin©), has paved the way for practical on-farm manipulation of reproductive seasonality of deer. Single implants in Fallow deer, and double implants in Red deer, are capable of elevating blood melatonin concentrations to levels comparable to peak night levels for periods of > 30 days. The effects of "swamping" the system with exogenous melatonin during summer closely parallels those of daily oral administration, without the hassles of constant daily labour inputs.

Regulin© Treatment Regimens for Deer

The desired degree of advancement of the calving/fawning season varies with locality and farm circumstances. The normal birth pattern for farmed deer in the northern regions of New Zealand is illustrated in Figure 1. For both species, the majority of offspring are born in December. Farmers in regions of equable summer rainfall may find that this pattern suits their pasture production. However, in most regions of New Zealand, pasture production peaks in October, with a subsequent decline in pasture growth and quality towards the end of December. Therefore, the maximum degree of advancement of the birth season may be in the order of six to eight weeks.

Fig 1: Pattern of births for Red deer and Fallow deer observed on farms in the northern region of New Zealand (1980 - 1984).



Quite clearly, the degree of advancement of the birth season has been shown to be related to the date of commencement of Regulin© treatment (eg Table 1). In yearling (pubertal) Red deer hinds, treatment initiation in early October has resulted in an average calving advancement of 48 days, this representing the maximum advancement that is likely to be desired within New Zealand. Treatment initiation towards the end of December has been shown to advance the calving pattern of Red deer by about two to three weeks.

It is interesting to note that when untreated Red deer hinds are run together with treated hinds, it is likely to result in a "social facilitation" effect, whereby the untreated hinds are also reproductively advanced (but generally to a lesser degree than treated hinds).

Table 1: Effect of date of Regulin© treatment of yearling Red deer hinds on the mean date of first oestrus and calving (G W Asher; Animal Reproduction Science 22, 1990).

First implantation date	First oestrus (mean date) to mean date of first oestrus	Interval from start of treatment	Calving (mean date) advancement	Degree of calving
2 October	26 February	147 days	24 October	48 days
17 November	5 March	109 days	3 November	38 days
30 December	29 March	90 days	21 November	20 days
Control	20 April	-	11 December	-

Similarly, running untreated Red deer hinds with Regulin© treated stags can result in moderate degrees of reproductive advancement of the hinds (Table 2). Such social facilitation effects have not been demonstrated following Regulin© treatment of Fallow deer.

Table 2: Effect of Regulin© treatment of Red deer stags and hinds on mean calving date in New Zealand (M W Fisher & P F Fennessy; Animal Production 51, 1990).

	Mean calving date	Range
(a) Untreated stags		
Untreated hinds (n = 9)	4 Dec	(19 Nov-26 Dec)
Treated hinds (n = 9)	23 Nov	(15 Nov-6 Dec)
(b) Treated stags		
Untreated hinds (n = 9)	21 Nov	(13 Nov-2 Dec)
Treated hinds (n = 9)	14 Nov	(8 Nov-22 Nov)

As male deer are also highly reproductively seasonal, with respect to semen production, Regulin© treatment should be applied uniformly to both sexes if the desired advancement of calving exceeds two weeks. There is a real danger that reproductively advanced females cannot be inseminated adequately by untreated males.

Problems Associated with Regulin© Treatment

There are several considerations in the application of exogenous melatonin control of reproductive seasonality in deer.

1. Cost - benefits: Presently, per animal treatment costs range from $10-$20, depending on current pricing of implants and the number of implants administered during the treatment period. Few studies have yet evaluated the increased financial returns that may result from Regulin© treatment. Clearly, increased productivity, in terms of venison production, will be reflected by increased carcass weights at a given age or season. Present schedule prices for venison would require additional carcass weights in excess of 3-4 kg to offset the cost of treatment of breeding females in the previous season.

   While a number of studies have shown that weaning weights have been increased by 5-10 kg by advancing the birth season by three to four weeks, this seems to reflect calf/fawn age at weaning, rather than increased daily weight gains. Furthermore, liveweight (and carcass weight) differentials between early and later born animals seem to diminish as they get older, thus negating the effects of earlier treatment of females.

   Further consideration needs to be given to increased potential profitability from marketing larger weaners and any management changes associated with changes in feeding strategies.

   If Red deer farmers desire only modest degrees of advancement of the calving season (i.e. two to three weeks) they may consider Regulin© treatment of stags only, and therefore reduce the overall costs of treatment by relying on social facilitation effects.

2. Treatment of pregnant female deer is contra-indicated, due to putative suppressive effects of exogenous melatonin on the initiation of lactation following parturition. This was first demonstrated

for Fallow deer, whereby >80% of does receiving implants from ~ 40 days before parturition failed to lactate and rear fawns. Recent studies at Ruakura have clearly demonstrated that the same phenomenon can occur in Red deer hinds when treatment is initiated ~80 days before parturition (i.e. early October).

Presently, Regulin© is licensed for use in pubertal female deer only, so as to avoid problems associated with pregnant females. However, several studies have demonstrated that initiation of Regulin© treatment **after** the initiation of lactation does not appear to result in reduced lactational yields or calf/fawn growth rates. This would, therefore, allow for treatment of adult females soon after parturition.

3. Advanced birth dates for both species are sometimes associated with precocious puberty, whereby males undergo their first antler cycle by six to eight months of age and females exhibit pubertal oestrus at about the same age. The implications of this have yet to be assessed but it is probable that precocious puberty is counter-productive. For example, the "bolter" syndrome in young male Red deer and Fallow deer is associated with reduced growth potential, due to induction of a "rut" condition at six to eight months of age. This may partly account for the decreased differential in liveweight of early vs late born males at 12-16 months of age. The phenomenon of precocious puberty is particularly pronounced for offspring born as early as September and early October.

4. Melatonin is the endocrine messenger for seasonal changes in appetite and hair growth. Advancement of reproductive seasonality by use of Regulin© treatment is parallelled by perturbations in other seasonal characteristics. While these changes have not necessarily been shown to be counter-productive, consideration must be given to animal welfare. For example, development of a thick, winter coat in summer might be associated with hyperthermia under certain circumstances.

5. Advancement of the breeding season is concomitant with an early cessation of reproductive capability. For example, stags/ bucks induced into rutting activity two months early will also tend to enter reproductive quiescence two months early. This will be manifested as earlier attainment of seasonal infertility and advanced antler casting/velvet growth. Again, consideration needs to be given to the welfare of these animals.

6. Spring births (Sept/Oct) may occur during periods in inclement weather, resulting in excessive post-natal mortality of calves/fawns. This has been particularly noticeable with Fallow deer, for which smaller birth weight renders fawns more susceptible to hypothermia. Excessive degrees of reproductive advancement (i.e. >40 days) may, in fact, prove to be counter-productive due to calf/fawn losses.

7. Recent controversy has emerged over the use of "chemicals" and "hormones" in farmed deer production. The protagonists of the "clean, green" image perceive repercussions from the marketing of products produced with the aid of synthetic and exogenous hormones. While one can argue that "exogenous melatonin" is identical in chemical form to "endogoneous melatonin"; that melatonin is a rather benign hormone found in all mammalian species (including man); and that Regulin© implants are not normally delivered to stock intended for venison production; the fact remains that the "anti-chemical" lobby heed emotional issues, rather than listen to objective facts. The NZ deer farming industry will need to decide whether the potential benefits arising from the use of melatonin are justified, given the perceived risks to international venison markets.