Effect of melatonin implants, flushing and teasing on the reproductive performance of spring-mated Dohne Merino ewes

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The effect of melatonin implants, flushing and teaser rams on the reproductive performance of spring-mated Dohne Merino ewes was investigated. The ewes (n = 534) were randomly allotted to four treatments, namely (1) no treatment (control), (2) melatonim implants (melatonin), (3) flushing and teaser rams (flushing and teasers), and (4) melatonin implants, flushing and teaser rams (combined treatment). Ewes in groups 2 and 4 were implanted with melatonin 32 days before commencement of the mating season (16 November 1990). In groups 3 and 4, ewes were supplemented with 400 g of chocolate maize/head/day from three weeks before to the end of the mating period and vasectomized rams were introduced 10 days prior to mating. Conception rate, lambing percentage and fecundity were significantly higher ($P < 0.05$) in the melatonin treatment group (group 2) (93.5%, 105.4% and 1.13, respectively) than in control ewes (86.6%, 91.0% and 1.05, respectively). A higher ($P < 0.05$) lambing percentage was recorded in group 3 than in the control group (99.3% vs. 91.0%). When compared with the control treatment (5 December, $SE \pm 4.5$ days), the mean dates of the first recorded oestrus ('first oestrus') during mating were 21 November ($SE \pm 1.6$ days), 28 November, ($SE \pm 3.98$ days) and 30 November ($SE \pm 5.14$ days) for groups 2 ($P < 0.01$), 3 ($P < 0.05$) and 4 ($P < 0.05$), respectively. When compared with the control treatment (33 days), the spread of first oestrus was 18, 28 and 27 days for groups 2 ($P < 0.01$), 3 ($P < 0.05$), and 4 ($P < 0.05$), respectively. However, no synergistic effect on reproduction and date of first oestrus above group 2 was found when melatonin-implanted ewes received the supplementation and stimulation with teasers (group 4). In animals treated with melatonin only (group 2) the onset of oestrus was earlier and the reproduction performance was higher than in other treatments ($P < 0.05$). At current prices melatonin treatment is more cost-effective than flushing and teasing.

Die effek van melatonieninplanting, prikkelvoeding en koggelramme op die reproduksieprestasies van lente-gepaarde Dohne Merino-ooie is ondersoek. Ooie (n = 534) is ewekansig in vier behandelingsgroepe, naamlik (1) 'n onbehandelde groep (kontrole), (2) groep met melatonien geïnplanteer (melatonien), (3) met prikkelvoeding en koggelramme (prikkelvoeding en koggelramme), en (4) met melatonieninplantings, prikkelvoeding en koggelramme (gekombineerde behandeling), ingedeel. Ooie in groepe 2 en 4 is 32 dae voor die aanvang van paartyd (16 November 1990) met melatonien geïnplanteer. Ooie in groepe 3 en 4 het 400 g sjokolademielies/kop/dag vanaf drie weke voor, tot die einde van paartyd ontvang en koggelramme is 10 dae voor paring by ooie in dié groepe geplaas. Besetting, lampersentasie en fekunditeit was betekenisvol hoër ($P < 0.05$) by die melatonienbehandeling (groep 2) (93.5%, 105.4% en 1.13, onderskeidelik) as by die kontrolegroep (86.6%, 91.0% en 1.05, onderskeidelik). Ooie in groep 3 het 'n hoër ($P < 0.05$) lampersentasie as die kontrolegroep gehad (99.3% vs. 91.0%). In vergelyking met die kontrolegroep (5 Desember, $SF \pm 4.5$ dae) was die gemiddelde datum van die eerste aangetekende estrus ('eerste estrus') van ooie tydens paartyd 21 November ($SF \pm 1.6$ dae), 28 November ($SF \pm 3.98$) en 30 November ($SF \pm 5.14$) vir groepe 2 ($P < 0.01$), 3 ($P < 0.05$) en 4 ($P < 0.05$), onderskeidelik. In vergelyking met die kontrole (33 dae) was die verspreiding van eerste estrus 18, 28 en 27 dae onderskeidelik vir groepe 2 ($P < 0.01$), 3 ($P < 0.05$) en 4 ($P < 0.05$). Geen bykomende verhoging in reproduksie en aanvang van eerste estrus is bo dié van groep 2 gevind toe melatonienbehandelde ooie ook geprikkel en gekoggel was nie (groep 4). Ooie wat slegs met melatonien behandel is (groep 2) se datum van eerste estrus was vervroeg en die reproduksieprestasie was betekenisvol bo dié van ander behandelings verhoog. Teen heersende pryse is melatonienbehandeling meer koste-effektief as die gebruik van prikkelvoeding en koggelramme.

Keywords: Flushing, melatonin, teasing.

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Introduction

The generally accepted concept that natural grazing has a good feeding value during spring and early summer dictates, from an economic point of view, a spring or early summer lambing season for the greater part of the eastern grassveld regions of South Africa (Adler, 1964). Despite the need for supplementary feeding, autumn or early winter lambing is generally recommended owing to a lower incidence of internal parasites during these periods. Reyneke (1969) reported that Dohne Merino ewes mated in autumn produced 27,5% more lambs than ewes mated in spring. A reduced incidence of oestrus in spring and early summer (Shelton & Morrow, 1965; Watson & Radford, 1966) is an important factor which contributes to the low lambing percentage associated with spring mating.

If the ewes of some sheep breeds are preconditioned during spring by a period of isolation from rams, the introduction of rams will induce a series of neuroendocrine responses which will result in oestrus, ovulation and conception (Lishman & De Lange, 1975; Martin *et al*, 1986). Significant increases in ovulation rate can also be achieved when ewes are flushed for at least one oestrous cycle before mating, but only when ewes are in store or moderate condition at the time when flushing begins (Allen & Lamming, 1961; Haresign, 1981; Gunn *et al.*, 1991). Consequently, management practices such as flushing and the use of teaser rams can assist sheep farmers to overcome the seasonal limitation of efficient lamb production.

The importance of the pineal gland and its hormone melatonin in the control of the breeding season in the ewe was reviewed by Bittman (1984) and Kennaway (1984). Timed administration of supplementary melatonin by feeding (Kennaway *et al.*, 1982; Arendt *et al.*, 1983), injection (Nett & Niswender, 1982) or infusion (Bittman & Karsch, 1984) can stimulate an early onset of breeding activity by pharmacologically mimicking the onset of short photoperiodic conditions. Continuous melatonin administration via subcutaneous implants (English *et al.*, 1986) or vaginal implants (Nowak & Rodway, 1985) is probably perceived as a 'very short-day' response (Lincoln & Ebling, 1985) and can also induce early breeding activity. Control of mating time by a suitable melatonin treatment could induce ewes to show an autumn peak of reproductive performance at the time of joining in spring.

Therefore, the objective of this study was to determine whether melatonin implants in Dohne Merino ewes during spring is a more successful alternative to increase lambing percentages than traditional management practices such as flushing and the use of teaser rams.

Material and Methods

The study was conducted on Dohne Sourveld (Acocks, 1975; veld type 44) at the Dohne Agricultural Development Institute (27° 29′ E and 32° 29′ N). Camps used in this study were homogenous regarding species composition and grazing capacity. During October 1990 Dohne Merino ewes (n = 534), previously mated in spring, were randomly allocated to four treatments according to stratification by age (2.5–6.5 years) and live mass. The treatments were (1) control, (2) melatonin implants (melatonin), (3) flushing and teaser rams (flushing and teasers), and (4) melatonin implants as well as flushing and teaser rams (combined treatment). To exclude a possible 'ewe or ram effect', treatment groups were isolated from each other by sight, smell and sound. A stocking rate of 18 SSU/ha was applied in all four groups.

On 14 October 1990 all ewes in treatment groups 2 and 4 received a subcutaneous implant (containing 18 mg melatonin; Regulin, Regulin Ltd, Melbourne, Australia). According to Williams *et al.* (1986) the implants maintain plasma melatonin at 2 597 ± 279 p. molar for 37 days. Teasing with 2% vasectomized rams (groups 3 and 4) commenced on 6 November 1990 and continued until the start of the mating period on 16 November 1990. During the mating period (42 days) vasectomized rams were used to indicate ewes on heat at 8:00 and 16:00 and these ewes were then hand-mated with a fertile ram. From three weeks before mating to the last day of mating, ewes in groups 3 and 4 received supplementation with chocolate maize (protein-enriched maize) (Wentzel, 1982) at a level of 400 g/head/day.

After the mating period, the treatment groups were managed as a single flock on veld with access to a salt-phosfate lick (50:50) and live mass was recorded fortnightly. On 8 April 1991 the ewes were moved to oats pasture where lambing took place. The date of lambing and the birth status (number of lambs born/ewe) were recorded at parturition. The body mass of each lamb was recorded within 24 h from birth.

Differences between treatment means were tested for significance by analysis of variance and chi-squared analysis. The Mann-Whitney U test was used to compare non-parametrical results. The mean dates of first oestrus and of lambing were compared by t test and differences in the spread of dates were tested by variance ratio. All the results are expressed as the mean ± standard error of the mean (Genstat, 1987).

Results

Reproductive performance

The effect of flushing, teasing and melatonin implants on the reproductive performance of the experimental groups is presented in Table 1.

Table 1 Influence of melatonin implants, flushing and teasing on the reproduction performance of Dohne Merino ewes

Parameters	Control (Group 1)	Melatonin (Group 2)	Flushing and teasers (Group 3)	Melatonin, flushing and teasers (Group 4)
Ewes mated				
Number	134	128	137	131
Ewes lambed				
Number	116	120	120	117
Percentage conception	86.6[a]	93.8[b]	87.6[a]	89.3[a]
Lambs born				
Number	122	135	136	123
Lambing percentage	91.0[a]	105.4[b]	99.3[a]	93.8[a]
Fecundity	1.05[a]	1.13[a]	1.13[a]	1.05[a]
Number of twins	6	9	16	6

a < b ($P < 0.05$).

A significant difference ($P < 0.05$) was obtained between the percentage ewes lambed/ewes mated (conception rate) and percentage lambs born/ewes mated (lambing percentage) of melatonin-treated ewes in group 2 and the other treatments. Ewes that received the combined treatment (group 4) tended to have higher conception rates than ewes in the control and in the flushing and teaser groups. In group 3, flushing and stimulation with teasers resulted in a higher lambing percentage than in the control group. However, no synergistic effect on the lambing percentage above the melatonin group (group 2, 105.4%) was found when melatonin-implanted ewes received the additional treatments of supplementation and stimulation with teasers (group 4, 93.8%). Fecundity was the same in groups 2 (melatonin) and 3 (flushing and teasers), namely 1.13, but although not significant ($P > 0.05$), was 0.08 higher than the fecundity of 1.05 in groups 1 (control) and 4 (combined treatment). Supplementation with chocolate maize and the use of teaser rams had no beneficial effect on conception but increased the lambing rate (Table 1).

Body mass

The mean live mass change of ewes during the mating period is shown in Figure 1. According to Figure 1, body mass of all groups increased at a steady rate during the experimental period. Body mass of flushed groups (3 & 4), however, increased at a faster rate than body mass of those groups where flushing was not applied. The increases in body mass of groups 3 and 4 since the start of flushing were 11.49 kg and 10.48 kg, respectively. During flushing the unsupplemented groups (1 & 2) also showed marked increases in live mass of 6.55 kg and 8.59 kg, respectively. This resulted in a significantly ($P < 0.05$) higher body mass of the flushed groups (3 & 4) vs. groups 1 & 2 at the 7th week after the start of the mating period. After the mating period the differences in live mass were diminished and ewes had similar mean mass at lambing (64.5 kg ± 0.9). Birth mass of lambs (4.1 kg ± 0.3) in the different treatments was unaffected by treatment during the mating season.

Lambing patterns

The mean dates of first oestrus and the spread of dates on which first oestrus occurred, expressed as the number of days between the first and last ewe, are shown in Table 2.

When compared with the control treatment (5 December, *SE* ± 4.5 days), the mean dates of first oestrus in ewes were 21 November (*SE* ± 1.6 days), 28 November (*SE* ± 3.98 days) and 30 November (*SE* ± 5.14 days) for groups 2 ($P < 0.01$), 3 ($P < 0.05$) and 4 ($P < 0.05$), respectively. When compared with the control treatment (33 days) the occurrence of first oestrus was spread over 18, 28 and 27 days for groups 2 ($P < 0.01$), 3 ($P < 0.05$, and 4 ($P < 0.05$), respectively.

The cumulative lambing percentage against time is presented in Figure 2. Day 1 of the lambing period was the same for all groups. The application of melatonin implants caused an early

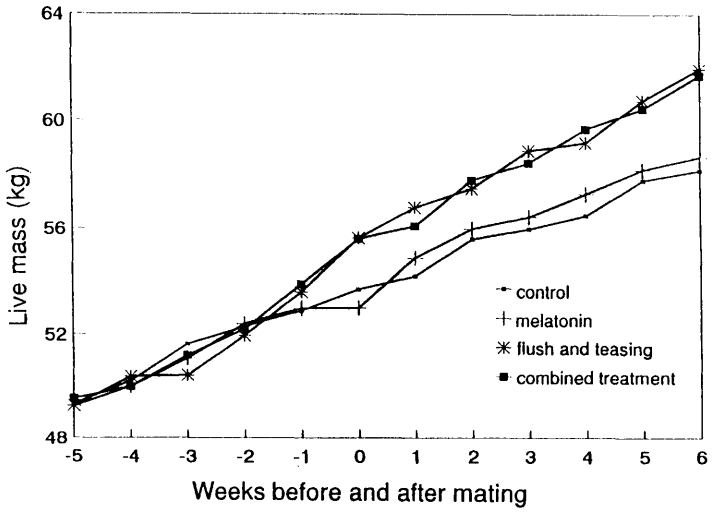

Figure 1 Mean live mass change of ewes in different treatment groups.

Table 2 Mean date of first oestrus, dates of first oestrus for first and last ewe in each group and spread of first oestrus by number of days in the experimental groups

Treatment	No.	First oestrus date		First oestrus date		Spread
		Mean	*SE*	First ewe	Last ewe	(days)
1. Control	134	5 Dec[a]	4.42	19 Nov.	22 Dec.	33[a]
2. Melatonin	128	21 Nov.[c]	1.57	16 Nov.	4 Dec.	18[c]
3. Flushing and teasers	137	28 Nov.[b]	3.98	18 Nov.	16 Dec.	28[b]
4. Combined	131	30 Nov.[b]	5.14	18 Nov.	15 Dec.	27[b]

a>b ($P < 0.05$); b>c ($P < 0.05$); a>c ($P < 0.01$).

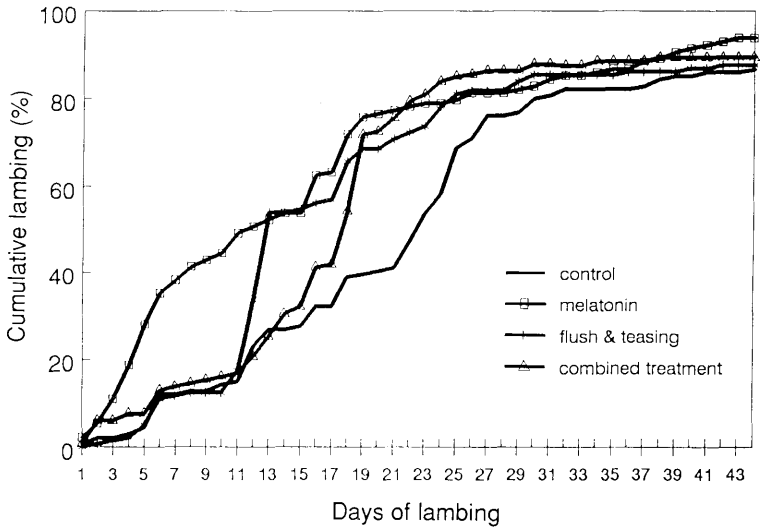

Figure 2 Cumulative lambing percentage of treatment groups.

onset of ovarian activity as indicated by dates of first oestrus. The mean lambing dates and the proportion of ewes lambing within 26 days of the first birth were higher in group 2 (melatonin) than in control ewes ($P < 0.05$). Within the first 12 days, significantly more ($P < 0.05$) ewes treated with melatonin only (group 2), lambed when compared with ewes that were flushed and stimulated by teasers (group 3). After day 26, no significant differences in the cumulative per cent lambing were, however, found between treatments (Figure 2). The ewes in group 4 that received the combined treatment only obtained similar cumulative per cent lambing during the first 19 days after the first birth. The stimulation effect of the teasers was evident after 11 days.

No significant ($P > 0.05$) differences in pregnancy duration between the treatments were found with the average duration of pregnancy being 150 ± 1.92 days.

Discussion

Melatonin administration, whether by a timed, daily application or by a continuous slow-release device, can advance the mean date of first seasonal oestrus in sheep (Kennaway *et al.*, 1982; Nett & Niswender, 1982; Arendt *et al.*, 1983; Bittman & Karsch, 1984; English *et al.*, 1986). In agreement with these studies, results from the present study demonstrate that continuous-release melatonin implants can influence reproduction in seasonally breeding Dohne Merino ewes. Ewes treated with melatonin only (group 2) showed an increase in overall reproductive performance. When compared with the control group, the major reasons for this increased performance were the significant increase in conception (93.8% vs. 86.6%) and increase in fecundity (1.13 vs. 1.05). This is in agreement with results of previous work which indicated that melatonin increases the ovulation (Wigzell *et al.*, 1986; Kouimtzis *et al.*, 1989) and conception rates (Luhman & Slyter, 1986). In the flushing and teaser group (group 3), a predictable pattern was seen: a higher ovulation rate was shown by those ewes which were in better condition and the action of the teasers improved the conception rate, but not to the extent that melatonin has done by advancing the onset of oestrous activity.

The lack of a marked response in reproduction rate to the combined treatment (group 4) is disappointing, but not entirely unexpected. The presence or absence of a ram effect must also be taken into account in the comparison of the various results. In some studies the ram effect was carefully excluded (e.g. Nowak & Rodway, 1985), whilst others used rams for both oestrus detection and mating (Kouimtzis *et al.*, 1989).

Robinson *et al.* (1985) and Mori *et al.* (1990) demonstrated a complementary effect of ram introduction and melatonin treatment. In the present study the melatonin, flushing and teaser group (group 4) has shown poor results. No synergistic effect was found on the onset of ovarian activity (Figure 2). An increase in conception rate over the flushing and teaser group was outweighed by poor fecundity, as was also seen in the control group. This could be attributed to a ram effect influencing the timing strategy of the melatonin treatment (Personal communication: S. Goddard, Essex CB10 1XL, UK, 1991). With the teasers being introduced only 23 days after treatment with melatonin, peak mating activity would have been induced only 40–50 days after melatonin treatment. This is still within the lag phase (of any form of melatonin or photoperiodic signal), and 10–20 days before the known peak of ovulation rates induced by Regulin, with the result that the lamb output per pregnant ewes was 1.05 rather than 1.13.

A feature of the present results is the significant reduction in the spread of dates of first onset of oestrus during the mating period following melatonin treatment (Table 2). In this study, the number of days separating the earliest and latest melatonin-treated ewes (group 2) was 18 compared with 33 days in the control group. Thus melatonin treatment advanced the date on which the first ewe of the group showed oestrus by 3 days, whereas the latest date was advanced by 18 days. Results presented by Arendt *et al.* (1983), Robinson *et al.* (1985), Staples *et al* (1986), Wigzell *et al.* (1988) and Kouimtzis *et al.* (1989) suggest a similar reduction in the period of first oestrus following melatonin treatment. For application to practical sheep production systems, the ability to advance the mean date of first oestrus and to condense the mating period around this date would be a useful attribute. Synchronization by progestagen treatment has commonly been used for advancing and condensing onset of oestrus. In some

circumstances, however, a less tight synchronization with, perhaps, a higher conception rate as in the melatonin-treated ewes in this trial, may be preferable.

The results from this study show that the omission of management factors, such as flushing and teasing, adversely affects the breeding performance of spring-mated Dohne Merino ewes. When compared with the control group, the flushing and teaser group leads to a benefit in terms of extra lambs per hundred ewes in the group. The question arises: which of these treatments is cost-effective? If the cost of a melatonin implant per ewe is R7.00, the cost of flushing with chocolate maize is R0.26 per ewe per day (400 g/ewe/day @ R0.64/kg) and the gross income per marketable lamb is R120.00, then the increase in value in terms of increased production above the control group is R1144.00 for the melatonin treatment (group 2; 14.4% more lambs), −R714.45 for the flushing and teaser treatment (group 3; 8.3% more lambs) and −R2 502.00 for the combined treatment (group 4; 3.8% more lambs). Thus, under the present circumstances only the use of melatonin is economically viable to increase the reproduction performance of spring-mated ewes.

It can be concluded that melatonin treatment enhances seasonal oestrus and increases conception and ovulation rates during spring mating. Optimum use of melatonin in collaboration with rams need to be established. In relation to the management objectives of South African sheep production systems, this approach could form a useful alternative or addition to the standard synchronization procedures.

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