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Fleece production patterns in Romney ewes: effects of photoperiod, pregnancy and lactation

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ABSTRACT

Twenty one Romney ewes were housed indoors for 12 months from February to determine the effect of season, pregnancy and lactation on wool growth. Ten ewes were naturally mated in April to lamb in September. The ewes were fed to maintain constant maternal body weight and a midside patch harvested monthly to determine clean fleece growth rates. An effect of pregnancy on individual fibre length growth rate, determined by autoradiography, occurred as early as 21-35 days after joining. During the second month of gestation, fleece production and mean fibre diameter fell below that of non-pregnant ewes and continued to diverge until parturition. Wool production rose in the non-pregnant group from August, but did not increase in lambing ewes until after parturition. These data suggest that pregnancy is associated with an early hormonally-mediated depression in follicle output superimposed on the decline associated with winter photoperiod.

Keywords: sheep; Romney; pregnancy; lactation; wool growth; nutrition; hormones.

INTRODUCTION

The decrease in wool growth rate during pregnancy has been estimated at between 20% and 45% (see review by Corbett, 1979). In Merinos, a small proportion of follicles may cease growth entirely (Schlink *et al.*, 1992). The decline in follicular output is associated with reduced fibre diameter, reduced staple length and reduced staple strength and may shift the position of break (Bigham *et al.*, 1983; Kelly *et al.*, 1992; Lee and Atkins, 1995). The depression in wool growth during pregnancy and lactation has been attributed to competitive demands for available nutrients by foetal development (Oddy, 1985; Williams and Butt, 1989). However, whether the mechanism is an indirect consequence of diverted nutritional flows, a direct endocrine effect on the wool follicle, or a combination of both is presently unknown.

A limitation of most previous studies has been the use of grazing sheep with potentially confounding changes in intake and maternal live weight. Under controlled conditions, a reduction in Merino wool growth has been reported by the third and fourth months of pregnancy relative to non-pregnant ewes (Corbett, 1966; Oddy, 1985). The present experiment was designed to establish the onset and duration of depressed wool growth in housed pregnant Romney ewes. Wool growth was measured in the period before joining and throughout pregnancy and lactation. The sheep were fed to a constant maternal live weight to minimise the effects of variable nutrient availability on follicle growth.

MATERIALS AND METHODS

Experimental animals and husbandry

Twenty-one Romney ewes were maintained indoors in single pens exposed to natural light from 8 February 1996 until 12 February 1997. They were divided into two groups balanced for February wool growth rate. Thirteen were synchronised using CIDR devices on 2 April and joined with rams between 17 and 19 April. Ultrasound scanning on 19 June indicated that two ewes were carrying twin foetuses and eight were carrying a single foetus. The three non-pregnant ewes were included in the control group (n = 11). The ewes were fed with lucerne pellets to maintain maternal live weight. From 14 July (day 87 of gestation) the daily feed allowance for the pregnant ewes was gradually increased until parturition to allow for the additional nutritional demands of the foetus. Over lactation, feeding was held constant at the maximum level reached during gestation. The feed allowance for the twin-bearing ewes was 1.2 times that of single-bearing ewes. Uneaten pellets were weighed daily to calculate individual intakes (Figure 1).

Measurements and sampling

The sheep were shorn on entry to the experiment on 14 February 1996. A 10x10 cm midside patch was established on 22 February and reclipped every month with Oster clippers until the sheep were shorn at the conclusion of the experiment in February 1997. Patch wool samples were washed in water and detergent and weighed at 16% regain. Clean wool production for each patch collection period was estimated by partitioning clean fleece weight according to the relative weight of clean wool clipped from the mid-side patch. Mean fibre diameter was measured by OFDA (Edmunds, 1995) by AgResearch Fibre Measurement, Invermay. Radiolabelling of a midside wool staple using ^{35}S cysteine was carried out at 14 day intervals between 26 March and 13 August using a modified method of Friend and Robards (1995). A second staple, in close proximity to the first, was similarly labelled until 14 January 1997. The mean distances between radiolabelled spots were determined using 33 fibres from each staple. All sheep were weighed at between weekly and monthly intervals for the duration of the trial.

Statistical methods

Feed intake, animal live weight and wool growth data were subjected to analysis of variance at each sampling time using DataDesk (Ithaca, NY) to test for effects of pregnancy and lactation. Initial live weights, clean wool growth and fibre diameter values were used as covariates in their respective analyses. The average of the first three length measurements was used as a covariate in determining differences in length growth rate. The results are expressed as covariate-adjusted means together with the standard error of the difference (SED) between treatment groups.

RESULTS

Eight single lambs and two sets of twins were born between 11 and 15 September with the mean lambing date being 13 September.

Feed intake and live weight

Up to the beginning of November, the total pellet intake was higher (P<0.001) in pregnant (287 ± 6 kg) than non-pregnant ewes (230 ± 1 kg) (Figure 1). Both treatment groups had a similar mean live weight up to 20 May (pregnant 48.1 kg, non-pregnant 46.6 kg; SED 0.8 kg) (Figure 2). By 19 June (day 62 after mating) the pregnant ewes weighed more than their non-pregnant counterparts (52.7 kg versus 50.4 kg, SED 0.8 kg; P<0.05) and gained more weight from 20 May to 30 August (15.6 kg versus 5.3 kg, SED 1.1 kg; P<0.001). Following parturition in September, the live weight differential between treatment groups was no longer significant (57.3 kg versus 54.8 kg, SED 1.3 kg; P<0.10). From February until the beginning of November, the live weight of pregnant and later lactating ewes increased by 7.4 kg. Over the same period, non-pregnant ewes increased by 4.8 kg (SED 1.6 kg, P>0.10).

FIGURE 1: Mean daily pellet intake of non-pregnant and pregnant Romney ewes. Open bar represents the period of feed adaptation; solid bar represents period of gestation; * indicates days when feed allowance was adjusted across one or both groups.

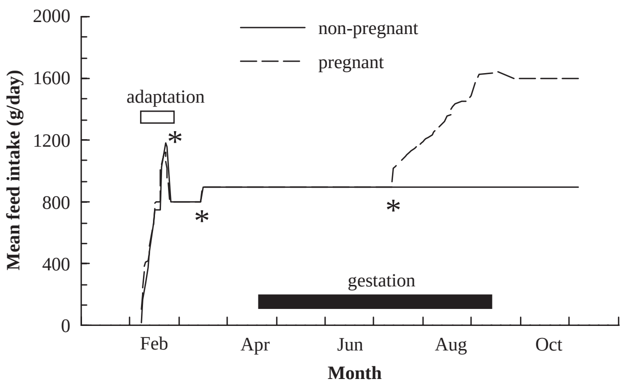
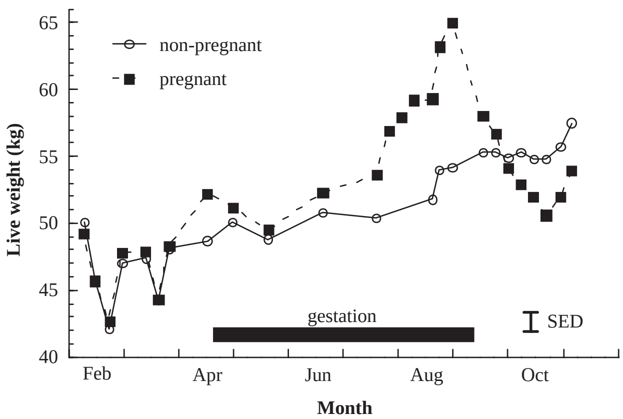


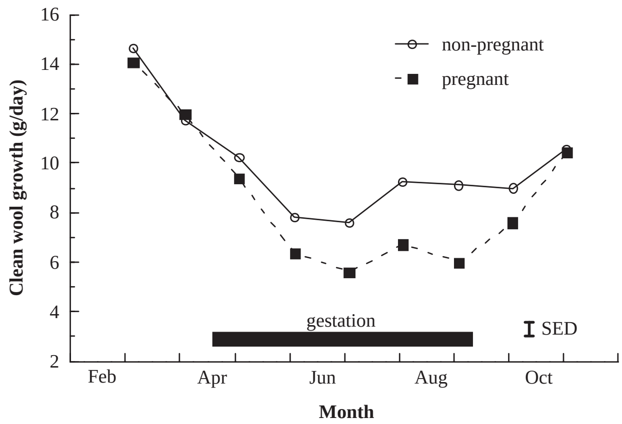
FIGURE 2: Mean live weight of non-pregnant and pregnant groups. Error bar represents pooled SED.



Wool growth

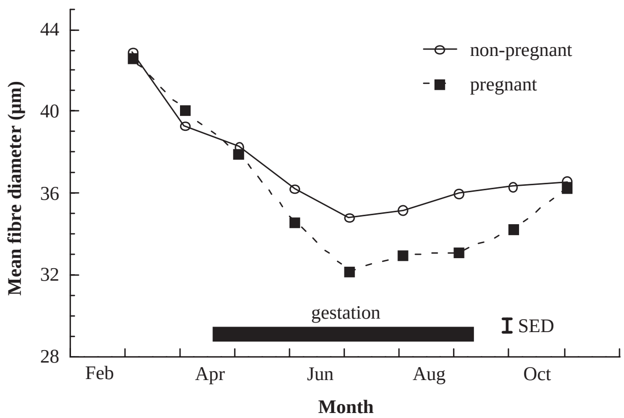
Monthly clean wool growth rate and mean fibre diameter in single- and twin-bearing ewes were not significantly different over the course of the trial. These data were therefore pooled in comparisons with the non-pregnant group. Clean wool growth declined in both groups from March with no measurable effect of pregnancy until June (Figure 3). From June to September average wool growth rate was 27% lower in pregnant ewes compared to non-pregnant ewes (6.3 versus 8.4 g/day, SED 0.4 g/day; P<0.001). By October, one month after lambing, the wool growth rate in lactating ewes had increased and was not significantly different from that in non-pregnant controls (7.8 versus 8.8 g/day, SED 0.6, P>0.10).

FIGURE 3: Mean clean wool growth rate of non-pregnant and pregnant groups. Patch wool data are plotted to the mid-point of the collection period. Error bar represents pooled SED.



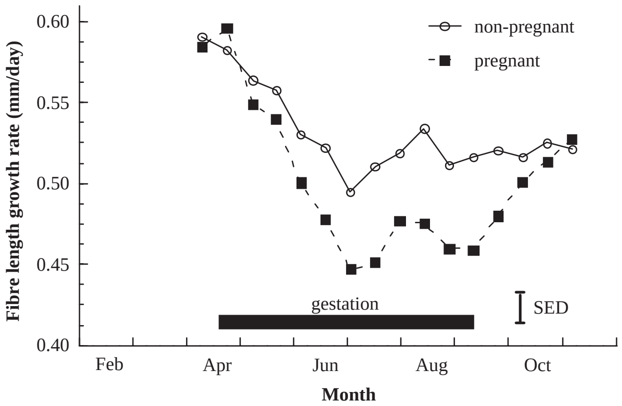
Monthly changes in mean fibre diameter generally reflected wool growth rate changes (Figure 4). While mean fibre diameter was similar in the two treatment groups in March and May, diameter in the pregnant group showed a tendency to fall below non-pregnant controls in June (34.6 versus 36.2 mm, 0.8 µm SED; P<0.10). In subsequent months, up to and including October, mean fibre diameter remained significantly less in pregnant and lactating ewes than in their non-pregnant controls (P<0.05).

FIGURE 4: Mean fibre diameter of non-pregnant and pregnant groups. Patch wool data are plotted to the mid-point of the collection period. Error bar represents pooled SED.



Fibre length growth rates did not differ between groups for the first 6 weeks of radiolabelling (Figure 5). A divergence first appeared between 10 and 22 May (22-34 days post-joining) (pregnant 0.54 versus non-pregnant 0.56 mm/day, 0.01 mm/day SED; P<0.10). Subsequently, pregnant sheep had significantly lower fibre length growth rates through gestation and early lactation (P<0.01) until the period between 26 September and 9 October (approximately 12-26 days after parturition) (0.50 versus 0.52 mm/day, 0.02 mm/day SED, P>0.10).

FIGURE 5: Mean fibre length growth rate of non-pregnant and pregnant groups determined by autoradiography. Error bar represents pooled SED.



DISCUSSION

The energy requirements of the growing conceptus during the first 100 days of gestation are relatively small. Over this period of gestation, recommended feed requirements for pregnant ewes do not differ from non-pregnant sheep (Robinson, 1983; Rattray, 1986). In the present experiment, mean live weights of the groups diverged by day 62 of gestation. The increased post-partum weights in September and November, compared to February weights, partially reflected fleece growth and mammary gland development. However, the differences in clean wool growth rate, fibre diameter and fibre length growth rate (which commenced as early as days 22-34 of pregnancy) were not associated with changes in either live weight or feed intake.

There is little comparable data on wool production for reproducing New Zealand sheep breeds held under controlled conditions. Under pastoral grazing conditions, a reduction of 14% and 23% in clean wool growth rate was recorded in single and twin-bearing Leicester x Romney ewes respectively between days 57 and 90 of pregnancy (Parker *et al.*, 1991). This is consistent with earlier findings by Henderson *et al.,* (1970) who recorded a difference in wool growth rate between pen-fed pregnant and non-pregnant ewes in the third month of pregnancy. Lee and Atkins (1995) also reported that grazing pregnant Merino ewes grew 8% less wool than non-pregnant ewes in early pregnancy (7 to 11 weeks after joining) without any differences in feed intake or live weight. In the present experiment, changes in fibre diameter over pregnancy followed the same trend as wool growth, contrary to Oddy (1985) who found no differences in Merino fibre diameter during pregnancy compared to non-pregnant ewes on a similar feed intake. The inhibitory effect on wool growth was associated with pregnancy rather than lactation. All three measures of wool growth (patch wool weight, fibre diameter and fibre length) suggest that wool growth increases markedly following parturition.

The results of the present trial indicate that the wool growth depression in early pregnancy is unlikely to be the result of simple competition for available nutrients between body tissues and the conceptus. The earliest time that we detected a change in length growth rate was between days 21 and 34 of gestation. This corresponds to the time of increased secretion of both progesterone (Bassett *et al.*, 1969; McNatty *et al.*, 1972) and placental lactogen (Kelly *et al.*, 1974; Chan *et al.*, 1978) in the maternal circulation. While neither hormone has reported effects on wool production (Wallace, 1979) further investigation in the pregnant ewe seems warranted. Both growth hormone (Wynn *et al.*, 1988) and cortisol (Chapman and Bassett, 1970) can inhibit wool growth under some circumstances. Although concentrations of these hormones are relatively low during early pregnancy, it is possible that inhibition of wool growth could be induced by a combination of these or other reproductive hormones.

Studies using Merinos have demonstrated that the decline in wool growth rate over early pregnancy can be counteracted by increasing feed intake (Masters and Stewart, 1990), suggesting that any inhibitory hormonal signal acting directly on the follicle is not an overriding mechanism. The situation regarding supplementary feeding in late gestation is less clear. Varying results have been obtained, but most studies suggest that the pregnancy effect cannot be entirely prevented by manipulating the quantity or the quality of the diet (Henderson *et al.*, 1970; Masters and Stewart, 1990; Masters *et al.*, 1992; Kelly *et al.*, 1992). It is possible that different mechanisms operate during late pregnancy to direct nutrients towards foetal growth. At this time the blood concentrations of some non-sulphur amino acids are significantly depressed (Masters and Stewart, 1990). Alternatively, an inhibitory endocrine signal commencing in early pregnancy could strengthen as the concentrations of some hormones, such as progesterone (Bassett *et al.*, 1969; McNatty *et al.*, 1972) and placental lactogen (Kelly *et al.*, 1974; Chan *et al.*, 1978), increase through gestation. Following parturition, wool growth rate increases rapidly, coinciding with the disappearance of gestational hormones from the circulation and despite an increase in the nutrient and energy requirements of the lamb compared to the foetus (Rattray, 1986).

CONCLUSIONS

A significant reduction in wool growth rate, measured using a sensitive radiolabelling technique, was observed within the first 50 days of pregnancy. The effect was not associated with changes in dietary intake or maternal live weight. These data suggest a direct hormonal influence on wool growth at an early stage of pregnancy. In late pregnancy, other influences could be important, but wool growth inhibition appears to cease following the birth of the lamb. The mechanisms involved need to be identified before strategies can be developed to ameliorate the adverse effects of reproduction on the quantity and quality of New Zealand crossbred wool.

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