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Repeatability of seasonal wool growth in Merino sheep

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ABSTRACT

Wool samples were clipped from the midside of 27 Merino rams and 33 unmated Merino ewes born in 1990 at 4 or 8 weekly intervals, depending on the season, between July 1991 and January 1994. Wool growth rate and mean fibre diameter were measured.

Both wool growth rate and mean fibre diameter exhibited seasonal growth cycles which were synchronous. The rhythm of the seasonal cycle for each characteristic was calculated as :-

Rhythm (%) = (Max-Min) / ((Max+Min) / 2) x 100.

The rhythm for wool growth rate exceeded that for mean fibre diameter while the rhythms for both characteristics increased significantly between the first and second year but not between the second and third years. Although wool growth rate and mean fibre diameter were strongly correlated between adjacent clipping periods, the derived rhythm estimates for both characteristics were only weakly correlated between years. Adjustment of the rhythm estimates for liveweight change during the same period significantly improved between sheep repeatability of the seasonality estimates.

These data indicate that a significant proportion of the variation in both wool growth rate and mean fibre diameter was, after adjustment for liveweight change, associated with permanent phenotypic differences among the sheep in the rhythm of their seasonal wool growth cycle.

Keywords: Merino; wool; seasonality; repeatability.

INTRODUCTION

Sheep possess an inherent seasonal cycle of wool growth which is entrained by the annual photoperiod (reviewed by Sumner and Bigham, 1993). The cycle has a maximum growth rate in the summer and a minimum growth rate in the winter with the amplitude varying between breeds (Bigham *et al.*, 1978). Wool growth rate is also directly affected by feed intake and indirectly by seasonal climatic effects on pasture quantity and quality. Under New Zealand conditions the Merino exhibits a less pronounced seasonal wool growth cycle than British long-wool type breeds (Sumner, unpublished). No published estimates of within-breed variation for seasonality of wool growth are known to the authors.

As part of physiological studies on control mechanisms regulating the seasonality of wool growth, it is proposed to develop a flock to show evidence of segregation of genes affecting seasonal wool production. This will be achieved by interbreeding identified sheep with a minimal and maximal seasonality of wool growth. This paper reports a study to quantify seasonality of wool growth and its repeatability in Merinos with a view to selecting individual Merino sheep with a low seasonality of wool growth.

MATERIALS AND METHODS

Twenty seven Merino rams and 33 unmated Merino ewes born at Whatawhata Research Centre in 1990 which survived to January 1994 were used. The sheep were separated into sex groups at weaning and grazed separately thereafter. Between July 1991 and January 1994 a midside patch area was clipped twice at approximately 4 weekly intervals during both the summer and winter and twice at approximately 8 weekly intervals during both the spring and autumn. The patch samples were washed, the total weight of clean wool grown on the clipped patch calculated and mean fibre diameter measured (Lynch and Michie, 1976). All sheep were shorn in July 1991, August 1992, August 1993 and January 1994. Individual greasy fleece weights were recorded at each shearing and a midside fleece sample taken for measurement of washing yield. Clean fleece weight was calculated from the yield of the full length midside sample. Clean wool growth rate during each period was estimated by proportioning clean fleece weight according to the relative weight of clean wool clipped from the midside patch during that period. All sheep were weighed in January and July each year.

Individual rhythm of both clean wool growth rate and mean fibre diameter was calculated as :-

Rhythm (%) = (Max - Min) / ((Max + Min) / 2) x 100 (Hutchinson and Wodzicka-Tomaszewska, 1961)

The derived estimates of rhythm for the periods winter 1991 to summer 1991/92, winter 1992 to summer 1992/93 and winter 1993 to summer 1993/94 were analysed by analysis of variance for sex and year effects.

RESULTS AND DISCUSSION

Mean clean wool growth rate and mean fibre diameter pooled over sex within each clipping period are presented in Fig.1. The seasonal cycles for both characteristics were synchronous with a minimum in July each year and a maximum in November each year. The timing of the period of minimum

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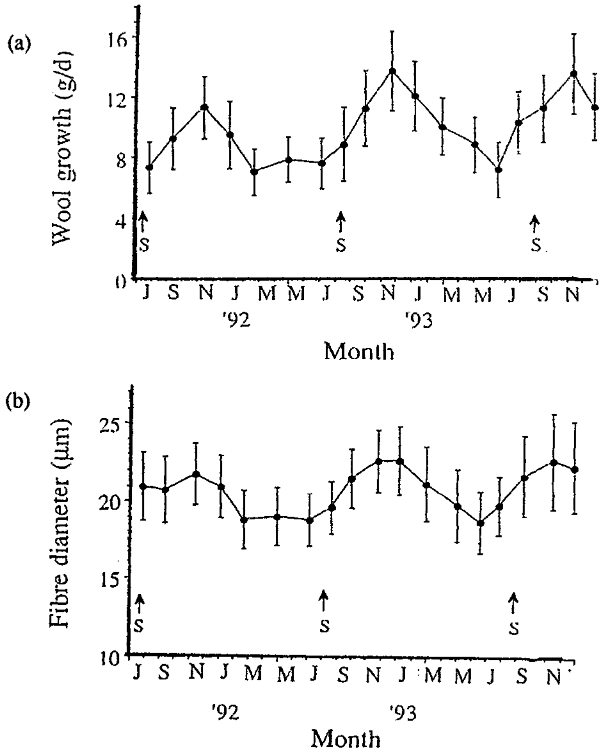
FIGURE 1: Mean values for (a) clean wool growth rate (± SD) and (b) mean fibre diameter (± SD) pooled over sex and plotted at the mid-point of each clipping period. S indicates time of shearing.



wool growth rate and minimum fibre diameter in this trial, coincides with the period of minimum wool growth previously reported for Romney, Coopworth, Perendale, Cheviot and Corriedale wethers at Whatawhata Research Centre (Bigham *et al.*, 1978). The timing of the period of maximum wool growth and maximum fibre diameter in this trial appears to be approximately 4 weeks earlier than for the breeds reported by Bigham *et al.* (1978). It is of interest that the wool growth rate of Corriedales (originally developed from crossing long-wool rams over Merino ewes) in the trial of Bigham *et al.* (1978) tended to decrease after the summer maximum before the other breeds, possibly reflecting a greater sensitivity to feed quality in Merino related breeds than in other more cyclic breeds (Brown and Williams, 1970).

The sex effect was not significant for either clean wool growth or mean fibre diameter. The mean rhythm of both characteristics increased significantly between the first and second years with values of 42.8 ± 15.7% vs 56.9 ± 20.2% for clean wool growth rate and 3.7 ± 7.1% vs 18.5 ± 6.2% for mean fibre diameter respectively. The mean rhythm of both wool growth rate and mean fibre diameter was not significantly different between the second and third years with mean values of 58.6 ± 20.8% and 18.6 ± 7.9% for wool growth rate and mean fibre diameter respectively. In this regard the Merino is similar to the principal coarse wool sheep breeds in New Zealand where the seasonal cycle of wool growth, and its associated characteristics, is smaller in young growing sheep than in adult sheep (Bigham *et al.*, 1978).

Wool growth rate is a function of mean fibre length growth rate, mean fibre cross-sectional area, density of active follicles within the skin and specific gravity of the fibre produced. Assuming all fibres were circular in cross-section the rhythm of (π x mean fibre diameter / 2)^2 was calculated as a measure of the rhythm of mean fibre cross-sectional area with values of 7.3 ± 14.4%, 36.5 ± 12.1% and 36.9 ± 18.6% for the first, second and third year respectively. As seasonal changes in either the density of active follicles or fibre specific gravity within Merinos are likely to be small, the magnitude of the rhythm for (π x mean fibre diameter / 2)^2 relative to wool growth rate infers a significant proportion of the variation in the weight of wool grown per unit time will also be associated with a concomitant change in fibre length growth rate (Woods and Orwin, 1988).

The magnitude of the rhythms for both wool growth rate and mean fibre diameter in these Merino sheep were approximately half values which can be derived from previously reported seasonal wool growth data for New Zealand's principal coarse wool breeds at the same location (Bigham *et al.*, 1978). The Merino is thus the most suitable of the breeds available within New Zealand as an example of a low rhythm breed to cross with a high rhythm breed for segregation studies.

Correlations among wool growth rate and mean fibre diameter measurements across all 18 samplings averaged 0.50 and 0.78 respectively. Repeatability estimates were lower in the period following shearing (0.32 and 0.71 respectively) than at other times of the year. Repeatability for the measured rhythm between years 1 and 2 and between years 2 and 3 was even lower at 0.13 and 0.31 for wool growth rate and 0.10 and 0.19 for mean fibre diameter indicating the presence of considerable variation due to fluctuating environmental effects.

There is a positive relationship between fibre growth and feed intake for sheep (Allden, 1979) which is in turn related to live weight change. As a means of reducing the environmental variation associated with these data the derived rhythm estimates for individual sheep were analysed by analysis of variance with liveweight change as a covariate, testing between year and between individual sheep effects. The covariate and between year effects for both wool growth rate and mean fibre diameter were highly significant ($P < 0.001$). Adjusted least square rhythm means for each successive year were 36.4, 62.4 and 61.0% (SED = ± 3.4%) for wool growth rate and 0.7, 21.0 and 19.2% (SED = ± 1.4%) for mean fibre diameter. Adjusting the data in this way had the effect of reducing the estimates for the younger actively growing sheep and increasing the values for the adult sheep. The between individual sheep effect, reflecting the tendency for sheep to retain a similar relative ranking across years, was significant for wool growth rate ($P = 0.003$) and approached significance for mean fibre diameter ($P = 0.068$). Adjustment of wool growth rate and mean fibre diameter for liveweight change during each period improved the adjusted R^2 (a measure of repeatability across all three periods) from 0.17 and 0.43 before adjustment, to 0.35 and 0.59 after adjustment, respectively. Adjusted mean rhythm for individual sheep pooled over the 3 years ranged between 21.3% and 88.2% (mean = 53.2 ± 13.7%) for wool growth rate and between 2.0% and 23.5% (mean = 13.7 ± 4.7%) for mean fibre diameter, indicating the presence of considerable between-sheep variation within this unselected group.

The adjusted rhythm estimates for both wool growth rate and mean fibre diameter were subsequently analysed by analysis of variance for a sex effect. Rams had marginally higher rhythms for both wool growth rate ($P=0.01$) and mean fibre diameter

(P=0.01) than ewes. As physiological concentrations of gonadotrophin hormones do not appear to effect wool growth (Wallace, 1979), the presence of a sex effect is suggestive that analysing wool production data with liveweight change over the period of measurement as a covariate, may be only partially effective in adjusting for possible environmental effects when comparing different grazing mobs. Separate analysis of live weight associations with wool growth rate and its components in different periods may be more informative.

CONCLUSIONS

A significant proportion of the variation present in both wool growth rate and mean fibre diameter in this group of Merino sheep has been shown to be associated with permanent phenotypic differences among the sheep in the rhythm of their seasonal wool growth pattern. While the repeatability of yearling with adult records was only about half that between adult records it was increased if allowance was made for the effects of liveweight change. This implies that phenotypic selection for these characteristics will be effective in identifying extreme individuals in a population as base stock for gene segregation studies, especially if based on repeated adult records.

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