
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

Seasonal patterns of wool growth in Romney sheep selected for high and low staple tenacity

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ABSTRACT

Fifteen ewes with extreme staple tenacity values at hogget shearing in 1991 were selected from each of the AgResearch High and Low Staple Tenacity selection lines. For two years wool was harvested monthly from midside patches and clean wool production, clean wool yield and fibre diameter mean and variation were determined. Staple tenacity, staple length and greasy fleece weight were measured at shearing each November.

Clean wool production followed the normal seasonal pattern for Romneys, with summer maxima 3-4 times higher than winter minima. Fibre diameter followed a similar pattern with maximum fibre diameters being 1.3-1.7 times greater than minimum values. Overall, the High Staple Tenacity group had greater staple tenacity ($P < 0.001$), staple length ($P < 0.01$), greasy fleece weight ($P < 0.05$), clean wool production ($P < 0.05$) and fibre diameter ($P < 0.001$) than the Low Staple Tenacity group and lower variability in fibre diameter ($P < 0.001$). Differences between the groups were most pronounced in winter.

Keywords: wool production; fibre diameter variability; seasonality; staple strength; Romney.

INTRODUCTION

The seasonal pattern of a summer maximum and a winter depression in wool growth shown by Romney sheep is well documented (Story and Ross, 1960; Morris, 1961; Ross, 1965; Bigham *et al.*, 1978; Geenty *et al.*, 1984; Woods and Orwin, 1988). Photoperiod is considered to be a principal determinant of the seasonal cycle, influencing both fibre diameter and length-growth (Hutchinson, 1976; Nagorcka, 1979). This seasonality is accentuated by nutritional level (Sumner, 1979, Hawker *et al.*, 1984) and, because of the contribution of fibre diameter to staple strength (Orwin *et al.*, 1987), there is an association between seasonality and staple strength (Hawker and Crosbie, 1985).

Selection for high and low staple tenacity in Romneys has produced sheep which differ not only in staple tenacity, but also in fleece weight, fibre diameter and staple length (Rogers *et al.*, 1990; Bray *et al.*, 1992). This study aimed to determine if differences in fibre diameter and wool growth between sheep with high and low staple tenacity were consistent throughout the year.

MATERIALS AND METHODS

The Romney sheep used were part of the AgResearch Staple Tenacity Flock at Templeton. This flock was established between 1986 and 1988, with positive, negative and random selection forming the High Staple Tenacity (HST), Low Staple Tenacity (LST) and Control lines, respectively (Bray *et al.*, 1992). Previously, these lines were termed the Staple Strength Selection Lines, but now the term Staple Tenacity is favoured (Scobie *et al.*, 1994a). Fifteen 1990-born ewes with the highest staple tenacity values, as measured at hogget shearing in November 1991, were selected from the HST line and 15 with the lowest values from the LST line. Throughout the study, these groups were run within the flock, in which all three selection lines received common treatment under commercial management conditions.

For two years from hogget shearing, wool was clipped monthly from midside patches. This wool was detergent-scoured and conditioned (20°C, 65% RH), and clean wool production, clean wool yield (clean wool as a percentage of greasy wool weight) and mean fibre diameter (OFDA method, Baxter *et al.*, 1991) were determined. Staple tenacity (the peak force required to break a bundle of fibres normalised for bundle cross-sectional area at the point of break (Scobie *et al.*, 1994a)), and staple length were measured on midside staples collected at shearing each November. Greasy fleece weight was recorded at shearing, and live weight was recorded monthly.

Analysis of variance techniques were used to determine differences between the HST and LST groups, allowing for year effects of the numbers of lambs born and reared.

RESULTS

Clean wool production showed a seasonal pattern (Figure 1a), with summer production levels 3-4 times higher than winter levels ($P < 0.001$). Clean wool yield declined from one shearing to the next (Figure 1b).

Fibre diameter followed a similar seasonal pattern to wool production (Figure 2a), with fibres attaining their greatest diameters in summer and least in winter ($P < 0.001$). The fibre diameter coefficient of variation varied from month to month ($P < 0.001$) but showed no consistent seasonal pattern (Figure 2b).

Over the two years of measurement, the HST group had greater staple tenacity ($P < 0.001$), staple length ($P < 0.01$), greasy fleece weight ($P < 0.05$), clean wool production

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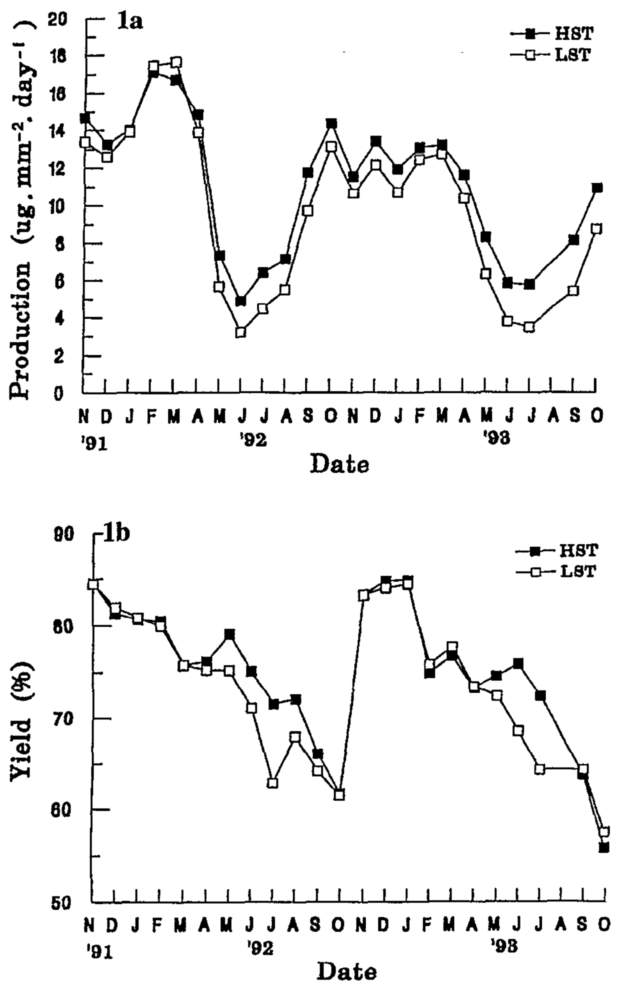
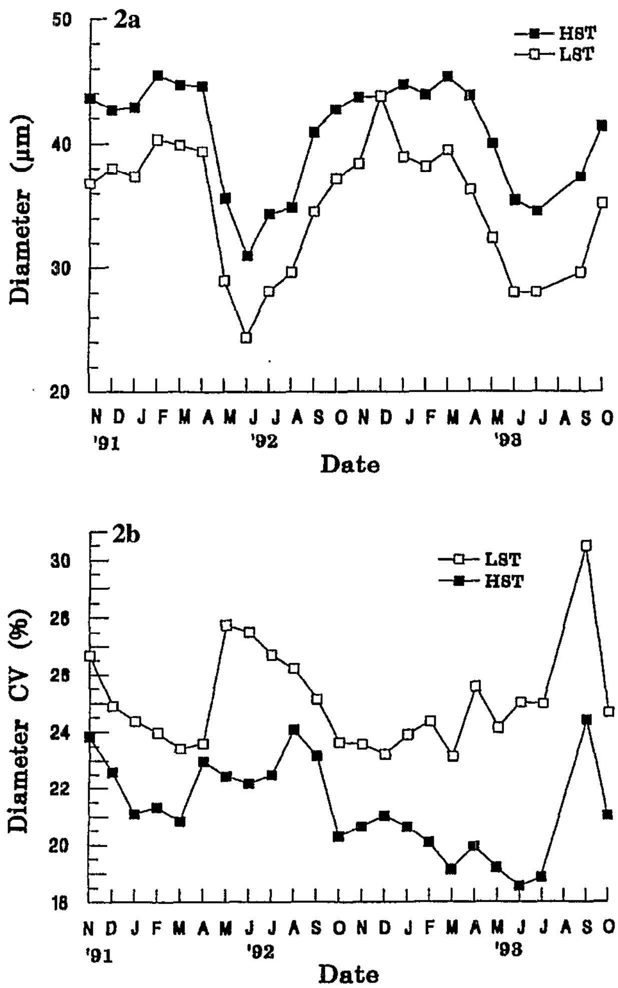
FIGURES 1a AND 1b: Mean values for (a) clean wool production (LSD (5%) 1.62) and (b) clean wool yield (LSD (5%) 4.29) for the HST and LST groups.



FIGURES 2a AND 2b: Mean values for (a) fibre diameter (LSD (5%) 2.12) and (b) coefficient of variation of fibre diameter (LSD (5%) 1.62) for the HST and LST groups.



($P < 0.05$), and fibre diameter ($P < 0.001$) than the LST group (Table 1). The coefficient of variation of fibre diameter was consistently higher ($P < 0.001$) in the LST than the HST group (Figure 2b, Table 1). Liveweight did not differ significantly between the tenacity groups (data not shown) and increased from 49.4 kg to 64.9 kg during the course of the study.

TABLE 1: Mean values for wool characteristics for the Low and High Tenacity groups over the 2 years.

Wool characteristic	Tenacity group Low	High	SED
Annual fleece samples			
Staple tenacity (N/kTex)	28.0	48.8	2.8
Staple length (cm)	16.4	18.6	0.6
Greasy fleece weight (kg)	3.9	4.4	0.2
Monthly midside patch samples			
Wool production (μg,mm^{-2},day^{-1})	9.9	11.1	0.6
Yield (%)	73.3	74.9	1.5
Fibre diameter (μm)	34.9	40.7	0.9
Fibre diameter CV (%)	25.1	21.3	0.6

Differences in wool production, yield, fibre diameter and the coefficient of variation of fibre diameter between the tenacity groups tended to be greater in winter than in summer, the LST group showing more pronounced seasonal patterns than the HST group. Wool growth rate was higher for the HST group than the LST group in both winters ($P < 0.01$), by 40% in the first winter and 47% in the second winter (Figure 1a). For the LST group, the summer maximum for wool production was 5.5 times the winter minimum in the first year and 3.8 times in the second year. Corresponding values for the HST group were 3.5 and 2.5 times. Clean wool yield (Figure 1b) was higher for the HST group in both winters ($P < 0.001$), the difference between the groups being 8% in both years.

A difference of 5-7 µm in mean fibre diameter was maintained between the groups throughout both years, except in December 1992 (Figure 2a). The difference was again greater in winter, fibre diameter of the HST group being 24% greater than that of the LST group in both winters ($P<0.001$). The maximum fibre diameter values for the LST group were 1.7 and 1.6 times greater than the minimum values in the first and second years, respectively, and those for the HST group 1.5 and 1.3 times. The difference between the tenacity groups for the coefficient of variation of fibre diameter was also greatest in the winter (Figure 2b), the LST group having values greater than those of the HST group, 22% greater in the first winter, and 31% greater in the second winter ($P < 0.001$ for both years).

DISCUSSION

The marked seasonal pattern of summer maxima and winter minima for clean wool production and fibre diameter shown by both the tenacity groups is similar to that previously reported for Romneys (Story and Ross, 1960; Bigham *et al.*, 1977, 1978; Geenty *et al.*, 1984, Hawker and Crosbie, 1985; Woods and Orwin, 1988). The reduced summer wool production peak in the second year probably reflected the demands of first-time pregnancy and lactation that year, as well as environmental differences between the years.

Differences in mean values of staple tenacity, staple length, greasy fleece weight and fibre diameter between the tenacity groups reflect differences between the HST and LST selection lines that have been reported previously (Rogers *et al.*, 1990; Bray *et al.*, 1992). However, the line contrast in staple tenacity was inflated by about 30% by the sheep sampling procedure used in this study. This inflation was particularly marked for the HST group which showed a much higher repeatability of hogget performance for staple tenacity, viz., 0.7 vs 0.1 (J.N. Clarke, unpublished data). The higher clean wool production of the HST group is in agreement with other studies which have shown a positive correlation between winter wool growth rate and staple strength (Geenty *et al.*, 1984, Bray *et al.*, 1993). The advantage in wool growth appears to be due to more efficient use of nutrients for wool growth in winter (Bray *et al.*, 1993, 1995).

The marked difference in the fibre diameter coefficient of variation between the tenacity groups throughout the study is of interest. It supports the findings of Scobie *et al.* (1994b) and Bray *et al.* (1995) that the LST line has an average standard deviation of fibre diameter greater than 'normal' wool of a similar diameter, and the HST line a lower than normal average standard deviation of fibre diameter. The variation measured by Scobie *et al.* (1994b) was for samples of wool grown over 10 months from lamb to hogget shearing, so included diameter variation both among fibres and along each fibre. As the values reported here were obtained from monthly growth periods, the along-fibre variation will be smaller than that in the Scobie *et al.* (1994b) data. Comparison of the magnitude of the coefficient of variation of fibre diameter in the three studies indicates that most of the variation arises from variation between fibres rather than along fibres. Scobie *et al.* (1995) have speculated that fibre diameter variability is a major component of staple tenacity in these selection lines. In studies of Merino sheep, total fibre diameter variation was found to be a prime determinant of staple strength, explaining up to 80% of the variation (Ritchie and Ralph, 1990; Lewer and Li, 1994).

Although the HST group had greater wool production, mean, fibre diameter, and yield, and lower coefficient of variation of fibre diameter throughout the study, the divergence between the groups was greatest in winter. The LST group showed a greater seasonal amplitude in wool production and mean fibre diameter. This is in agreement with other studies which have shown that sheep with pronounced seasonal profiles tend to have lower staple strength (Hawker and Crosbie, 1985; Hawker and Littlejohn, 1989).

These observations support conclusions that sheep chosen for extreme values in staple tenacity also differed in components of wool growth viz. staple length, average fibre diameter, and fibre diameter variability. Differences in wool growth between the sheep groups were greater in winter.

ACKNOWLEDGMENTS

The authors wish to thank Norma Merrick, Stuart Young, Denis O'Connell, David Scobie (AgResearch), Wayne Nelson, Ben Herbert and Richard Walls (WRONZ) for assistance with sheep sampling and sample processing; David Baird (AgResearch) for statistical analyses; David Scobie and Neil Clarke (AgResearch) for critically reading the manuscript and Barbara Vaile (WRONZ) for editorial services. This work was funded by the Foundation for Research, Science and Technology.

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