

REPEATABILITY OF THE RATE OF WOOL GROWTH ACROSS SEASONS IN A MEDITERRANEAN ENVIRONMENT

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SUMMARY

Sheep run in a Mediterranean environment undergo substantial changes in their nutritional status throughout the year as the quality and quantity of feed changes. We report 2 studies that examined whether these changes affect wool growth rates similarly in all sheep. Wool growth rates correlated closely ($r = 0.54$ to 0.76) within sheep across seasons when animals were on similar feed (green or dry), but correlations across green and dry feed were generally weaker ($r = -0.14$ to 0.57). Correlations for fibre diameter followed a similar pattern, with the fibre diameter measured in winter bearing no significant relationship to that measured in summer or autumn. The rate of wool growth on green feed (but not dry feed) was correlated inversely with staple strength. We conclude that the mechanisms controlling wool growth on dry feed are not identical to those active when sheep are on green feed. The animals selected for fleece weight or fibre diameter while grazed on dry feed will be poorly related to the group of animals that would be selected if they were grazed on green feed, with effects on genetic progress that are not fully known.

Keywords: wool growth, fibre diameter, season, feed quality

INTRODUCTION

The highly seasonal Mediterranean environment, such as occurs in south western Australia, results in large fluctuations in nutrient supply, with sparse green feed in winter, abundant green feed in spring, abundant dry feed in summer, and sparse dry feed in autumn. Sheep in this environment undergo constant changes in liveweight throughout the year, so their metabolic system is continually changing to maintain homeostasis. Wool growth also changes dramatically, but the extent to which wool growth simply reflects the availability of nutrients, and the extent to which it is modified by follicular dynamics or by the changing mechanisms that control the metabolic status of the sheep, is not known. The accompanying observations examine whether wool growth responded similarly in all sheep to the nutritional changes, to determine the extent to which control mechanisms might be important.

MATERIALS AND METHODS

Experiment 1

A flock of 35 adult South Australian-type merino wethers was grazed on subterranean clover-based pasture without supplementary feeding at the CSIRO research station at Bakers Hill, 80 km north east of Perth. Mean fleece-free liveweight averaged 61.7 kg in summer and 52.8 kg at the start of winter, a change of 13%. Animals were shorn on August 8 and mid-side dyebands were applied at changes of season as judged by the state of the pasture; end of winter (Sept 8), end of spring (pasture wilting; Nov 10), end of summer (point of maximum liveweight; Jan 24) and end of autumn (break of season; April 10). Animals were shorn in winter (July 4) and fleeces weighed. The weights of wool between the dyebands were measured, and the proportion of fleece grown in that time (g/day) was calculated. Staple strength and mean fibre diameter were measured by Australian Wool Testing Authority Ltd. Correlations between wool growth rates at different seasons were calculated and correlations between whole fleece characteristics and growth rates at different seasons were also determined.

Experiment 2

Thirty five pairs of Merino identical twins born over 2 years were studied in the experiment described by Kelly *et al.* (1996) at the Agriculture WA station at Katanning, 300 km south east of Perth. Lambs were born in June, shorn in September and dyebands were applied at 5 sites (top shoulder, bottom shoulder, mid-side, pin-bone and lower back leg) in December, March, May and June. Dyebands were removed in August and the tip discarded, leaving four dyeband periods, starting in December. The onset of green pasture occurred three weeks after the May dyeband was applied, so the periods represent summer, autumn, break

of season and winter. The growth rate of green pasture varied between the 2 years in this period, so that the relative amounts of green and dry feed during this period cannot be generalised. Animals were supplemented during autumn with lupin grain so that they continued to gain weight slowly, growing from 43.6 kg in January to 46.9 kg at the break of season. Wool length growth rates (mm/day) were measured between the dyebands and the fibre diameter was measured by an Optical Fibre Diameter Analyser on 2mm snippets just below each dyeband. Residual correlations were calculated after site effects and the experimental effects of treatment, sex, age of dam, and year were taken out, although the correlations among corrected values were not greatly different from the raw correlations.

RESULTS

Experiment 1

The mean greasy fleece weight over the 330 day period was 5.4 kg, the mean yield was 78% and the mean fibre diameter was 23.2 μm . Estimated average clean wool growth (g/head.day) over the 5 periods was; winter, 17.5, spring 15.6, summer 9.2, autumn 10.5 and following winter 13.8.

As shown in Table 1, rates of wool growth correlated more closely when animals were on similar feed (green or dry). That is, correlations of winter with spring, or summer with autumn, were relatively high. Correlations between periods of dry and green feed were generally lower, even though they may have been closer in time (eg, spring correlated less with autumn than with the following winter).

Table 1. Matrix of correlation coefficients among rates of wool growth in five successive seasons

	Winter 1	Spring	Summer	Autumn
Spring	0.54**			
Summer	0.24	0.57**		
Autumn	0.27	0.38*	0.72***	
Winter 2	0.47**	0.76***	0.35*	0.45**

*P < 0.05, ** P < 0.01, ***P < 0.001.

Table 2. Correlation coefficients among rates of wool growth at different seasons and characteristics of the whole fleece

	Winter 1	Spring	Summer	Autumn	Winter 2
Fleece wt	0.75***	0.86***	0.64**	0.66**	0.84***
Fibre diam	0.12	0.24	0.36*	0.43**	0.10
Staple str.	-0.41**	-0.46**	0.06	0.17	-0.54**

*P < 0.05, **P < 0.01, ***P < 0.001.

As might be expected, the greasy fleece weight correlated with wool growth rates at all seasons, but the strongest correlations occurred while the animals were on green feed (Table 2). The staple strength of the fleece was inversely correlated with the rate of wool growth in animals on green feed, but bore no relationship to wool growth during autumn (Table 2). Surprisingly, there was a significant correlation between rate of wool growth while the sheep were on dry feed (summer and autumn) and overall fibre diameter of the fleece, but no such correlation when the sheep were on green feed. The overall correlation between fibre diameter and greasy fleece weight was 0.28 (NS).

Experiment 2

The mean greasy fleece weight over 356 days was 5.6 kg, with a yield of 74.3%. Mean fibre diameters for summer, autumn, break of season and winter were 18.3, 19.3, 22.0 and 21.7 μm respectively and corresponding length growth rates were 0.21, 0.29, 0.31 and 0.30 mm/day.

Rates of wool growth correlated well across seasons with similar feed (summer and autumn; Table 3), but correlations of wool growth between green and dry feed (summer and winter) were low. Correlations

for fibre diameters showed a similar pattern. The fibre diameters were measured at the point of the dyeband, which for break of season period was before the opening rainfall, so fibre diameter for that period correlated with periods of dry feed (summer and autumn).

Table 3. Correlation among wool growth rates and fibre diameters (bold and below) in dyebands at 4 times of the year

	Summer	Autumn	Break of season
Autumn	0.61*** 0.73***		
Break of season	0.09 0.70***	0.35** 0.72***	
Winter	-0.14 0.12	-0.13 - 0.14	0.59*** 0.31**

P < 0.01, *P < 0.001.

DISCUSSION

Rates of wool growth would be expected to correlate most closely with measurements taken in the periods immediately adjacent. However, in both experiments this pattern was disrupted, in that wool growth measurements taken while sheep were on green pasture (winter, spring, following winter) correlated well with each other (Tables 1 and 3), but less so with measurements taken on dry feed (summer, autumn). Correlations within the period of dry feed (summer and autumn) were also high. Anomalies in correlations of fibre diameter measured in Experiment 2 were even more marked, being very high when animals were on dry feed, but low or even negative when measurements taken when sheep were on dry feed were compared with those on green feed (Table 3). These differences may be exaggerated by fibre diameter being measured at a single point, rather than averaged across the dyeband period. Nonetheless, these changes in the magnitude of the correlations between seasons indicate that the mechanisms controlling wool growth in sheep on green feed were not identical to those active in sheep on dry feed, so that the sheep that grew wool well on green feed were not necessarily those that did best on dry feed.

It is common practice for lambs to be shorn in spring and selected after shearing again in March or April, so that genetic selection occurs during the time when animals are pastured primarily on dry feed. The present results indicate that the group of animals selected for fleece weight or fibre diameter under such conditions will bear little relationship to the group that would have been selected if the animals had been grazed only on green feed. The implications of this practice for the genetic progress of the flock cannot be predicted from current knowledge, but may have a substantial impact on the rate of improvement of the overall fleece (Lax and Jackson 1987).

Staple strength depends primarily on the change in the amount of wool along the staple, with intrinsic strength playing a minor role (Gourdie *et al.* 1992). This is confirmed by the correlation between high wool growth in spring and low staple strength (Table 2), because the greatest differences in wool growth occur in spring, and the sheep that respond most to the spring flush of feed are not necessarily those that will grow large amounts of wool during autumn. Surprisingly, the rate of wool growth during the weakest point of the staple (autumn) was not significantly correlated with staple strength. If these phenomena have a genetic base, it may impede progress with selection for high staple strength, because wool growth on green feed was closely correlated with total fleece weight (Table 2). However, the phenotypic correlation between fleece weight and staple strength in this experiment was -0.40, while the phenotypic correlation between staple strength and fleece weight in *hoggets* is normally positive and ranges between 0.03 and 0.22 (Greeff *et al.* 1995), so the extent to which this result can be generalised is not yet clear.

In contrast to fleece weight, the overall fibre diameter of the fleece in Experiment 1 was most closely related to wool growth in summer and autumn (Table 2). The relatively small amount of wool grown in autumn is unlikely to determine the fibre diameter of the whole fleece, so this correlation suggests sheep with a broader fleece grew wool better on dry feed, but that on green feed this mechanism was not important. The factors controlling wool growth in sheep on green feed are also not fully characterised. Adams *et al.* (1994) showed that in a Mediterranean environment, wool growth in spring was not dependent on feed intake and liveweight growth, but were unable to determine why this was so.

The need for individual sheep to produce wool over a range of environments is a competitive disadvantage for the sheep industry, compared with more intensive industries where the environment is better controlled. The efficiency of the wool industry would be much improved if cost-effective means to modify the environment sufficiently to prevent the interactions described in this paper could be developed. However, this may be difficult to achieve if it is assumed that the major difference between spring and autumn was the quantity and quality of the feed supply. The **hoggets** in Experiment 2 were well supplemented with lupin grain so that they did not lose weight, and yet the phenotypic interactions were no less than in Experiment 1, where the adult animals were unsupplemented and lost 13% of liveweight. It seems likely that more sophisticated procedures involving a better protein source will be required if environmental modification is to be successful.

ACKNOWLEDGEMENTS

We thank M. Sanders, D. **Buscall** and M. **Yelland** for assistance with the sheep and dyebands. The work was supported in part by Australian wool growers through the International Wool Secretariat.

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