RELATIONSHIPS BETWEEN STAPLE STRENGTH AND RATE OF CHANGE OF LIVEWEIGHT OVER SUMMER-AUTUMN IN MERINO SHEEP

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SUMMARY

Positive ($P<0.05$) linear relationships were established between staple strength and rate of change of liveweight (LWC) over summer-autumn for experimental groups of sheep. Between 30 and 90% of the variation in staple strength could be explained by the LWC to the point of minimum liveweight for hoggets, adults and breeding ewes. The intercepts of these relationships differed significantly ($P<0.05$) although the slopes did not. The intercepts for hoggets indicated that autumn born weaners needed to grow at 10 g/day to produce wool with a staple strength of 32 N/ktex, whereas winter born weaners had to grow at 80 g/day. In contrast, adults fed to maintain liveweight over summer-autumn produced wool ranging in staple strength from 35 to 56 N/ktex. It appears that adults are better buffered against the decline in the quantity and quality of feed over summer-autumn than are hoggets.

Keywords: Merino sheep, staple strength, liveweight change, summer-autumn.

INTRODUCTION

In Mediterranean type climates, the rate of growth of wool declines dramatically during the long period of dry pasture over summer-autumn. During this period, woolgrowers attempt to manage the rate of growth of wool and hence staple strength by managing the rate of change in liveweight (LWC) of sheep. Low staple strength is a particular problem in young sheep and breeding ewes shorn in spring, a system of wool production that places the period of minimum wool growth/minimum diameter in the middle of the staple. This reflects the strong correlation between the rate of growth of wool, and the mean liveweight and LWC of sheep (Allden 1979). Similarly, Doyle *et al.* (1995) reported significant linear relationships between staple strength and LWC over summer-autumn for spring shorn hoggets within and across a range of supplementary feeding experiments. Between 30 and 50% of the variation in staple strength was explained by the LWC.

This paper investigates the relationships between staple strength and LWC over summer-autumn for hoggets, adult wethers, dry ewes and reproducing ewes across a range of experiments. A preliminary review suggested that in all cases the relationships were linear but that the intercepts and slopes might depend on factors such as age, physiological state and genotype.

MATERIALS AND METHODS

Classes of sheep

Hoggets 1 Fine (17.3 μm, 6 to 7 months of age) and medium (19.4 μm, 3 to 4 months) wool October shorn wether weaners with an average liveweight of 32 kg were offered one of four lupin feeding treatments at Merredin (200 to 400 mm rainfall), Kojonup (400 to 600 mm) and Green Range (600 to 800 mm) (Gherardi *et al.* 1996). The sheep were fed lupins for survival or to maintain liveweight: from early February; from pasture senescence in November and from pasture senescence plus tactical feeding of hay/lupins after rainfall events. They were weighed fortnightly during supplementary feeding, after which they were weighed monthly until shearing in October. The results presented are plot means for each of the four supplementary feeding treatments at the three sites (n = 12).

Hoggets 2 The experiments were conducted over a period of three years on the south coast of Western Australia (Doyle *et al*. 1995). The data presented came from two properties located at Wellstead (400 to 600 mm) and Denbarker (600 to 800 mm). The wether weaners were 6 to 6.5 months of age with an average liveweight ranging from 30 to 36 kg. The weaners were shorn as lambs in spring. Supplementary feeding commenced at pasture wilting after which the weaners were fed lupins, lupins coated with gypsum or lupins with access to a multi-element mineral lick to maintain liveweight. The sheep were weighed at three-weekly intervals during supplementary feeding, after which they were weighed monthly until shearing in spring. The

results presented are plot means for each of the three supplementary feeding treatments which were replicated three times. There were three years data for the properties at Wellstead (n = 27) and two years for Denbarker (n = 18).

Adult wethers and dry ewes Adult wethers and dry ewes phenotypically selected for high (SS+) and low staple strength (SS-) with an average liveweight of 70 kg were offered one of three lupin feeding treatments at Katanning (400 to 600 mm) (A.M. Ritchie pers. comm.) over two years. The sheep were fed lupins for survival or to maintain liveweight from either early February or from pasture senescence in November. They were weighed fortnightly during supplementary feeding, after which they were weighed monthly until shearing in October. The results presented are plot means for each of the three supplementary feeding treatments which were replicated three times (n = 9).

Adult wethers The experiment was conducted over two years at Kojonup (400 to 600 mm) using adult wethers (Doyle and Thompson 1992). There were two management treatments, set stocking (Set) and strip grazing (Strip), from early winter to late spring. The wethers were supplemented according to farm practice and were weighed regularly during summer-autumn. The results presented are for the two years and are plot means for the management treatments which were replicated four times (n = 16).

Breeding ewes The experiment was conducted at Martindale (400 to 600 mm) using adult reproducing ewes which were run in three separate paddocks over three years (Curtis pers. comm.). Three extra groups of ewes were included in the study in year three. The ewes were supplemented with lupins according to farm practice and were weighed regularly during summer-autumn. The results presented are plot means (n = 12).

Analytical methods, calculations and statistical analyses

In all experiments, LWC for sheep over summer-autumn was estimated from the slope of linear regression relating peak liveweight in early summer-autumn and the minimum liveweight in late autumn. Staple strength and position of break were measured using staples drawn from midside samples collected at shearing (Gardner *et al*. 1993). The date of the position of break was estimated as described by Doyle *et al*. (1995). Differences in the slopes and intercepts of the relationships were compared using a paired *t* test.

RESULTS

There were significant linear relationships between staple strength and liveweight change over summer-autumn in each of the five studies (Figure 1.). The slopes, intercepts, correlation coefficients, number of observations and the level of significance of the slopes are presented in Table 1.

Between 30 and 90% of the variation in staple strength could be explained by LWC over summer-autumn. There were no significant differences in the slopes of the relationships, however, there were differences between the intercepts.

The relationship for the medium wool hoggets had a significantly ($P<0.001$) lower intercept than those for the fine wool, Wellstead and Denbarker hoggets. The intercepts for the fine wool, Wellstead and Denbarker hoggets were similar. The relationships for the adults tended to have higher intercepts than those for the hoggets. Of the adults, those selected for high staple strength had a significantly ($P<0.05$) higher intercept

Table 1. Slopes, intercepts, correlation coefficients, number of observations and level of significance for the relationships between staple strength and liveweight change for groups of sheep in a wide range of experimental situations

Experiment	Intercept (±s.e.)	Slope (±s.e.)	r	n	P
Hoggets - fine	30.0 (0.55)	0.16 (0.026)	0.89	12	<0.001
Hoggets - medium	22.7 (0.60)	0.12 (0.020)	0.88	12	<0.001
Hoggets - Wellstead	30.0 (1.13)	0.16 (0.049)	0.55	27	<0.01
Hoggets - Denbarker	27.6 (1.69)	0.11 (0.027)	0.71	18	<0.01
Adult SS+	56.3 (7.34)	0.22 (0.061)	0.88	9	<0.05
Adults SS-	35.3 (5.17)	0.14 (0.044)	0.85	9	<0.05
Adult Set	37.1 (3.02)	0.17 (0.035)	0.85	16	<0.001
Adult Strip	45.6 (2.43)	0.20 (0.035)	0.94	16	<0.001
Breeding ewes	31.6 (0.18)	0.13 (0.026)	0.84	12	<0.001

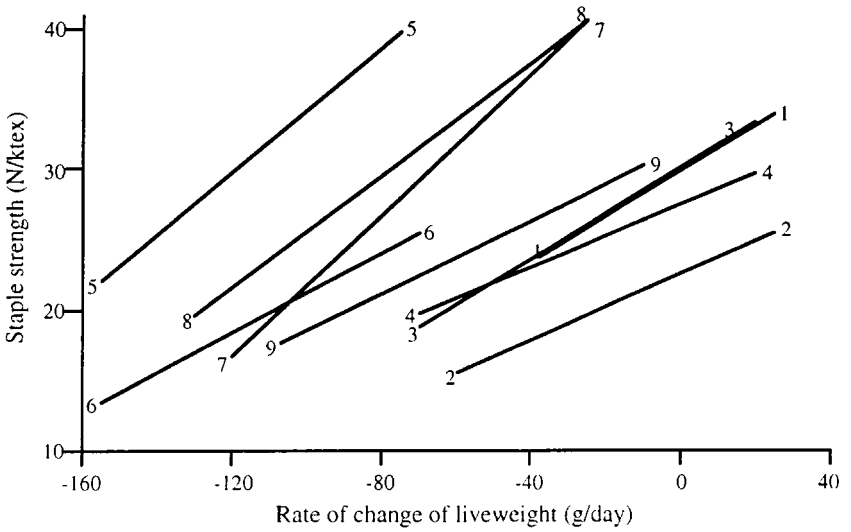

Figure 1. Relationships between staple strength and liveweight change over summer-autumn for groups of sheep in a wide range of experimental situations: 1, hoggets - fine (Gherardi *et al.* 1996); 2, hoggets - medium (Gherardi *et al.* 1996); 3, Hoggets - Wellstead (Doyle *et al.* 1995); 4, hoggets - Denbarker (Doyle *et al.* 1995); 5, adults - SS+ (A.M. Ritchie pers. comm.); 6, adults - SS- (A.M. Ritchie pers. comm.); 7, adults set (Doyle and Thompson 1992); 8, adults strip (Doyle and Thompson 1992); 9, breeding ewes (Curtis pers. comm).

than the adults selected for low staple strength and those which had been set stocked over winter/spring. The relationship for the breeding ewes had a similar intercept to the fine wool, Wellstead and Denbarker hoggets.

DISCUSSION

The results demonstrate significant linear relationships between staple strength and LWC over summer-autumn, across a wide range of experimental situations. Up to 90% of the variation in staple strength could be explained by the LWC over this period. The intercepts of these relationships differed although the slopes did not.

The intercepts of the relationships for the fine wool, Wellstead and Denbarker hoggets indicated that they needed to grow at 10 g/day to produce wool with a staple strength of 32 N/ktex, whereas the medium wool hoggets had to grow at 80 g/day to produce wool with the same staple strength. It is thought that the difference in these relationships was due to the stage of maturity of the hoggets going into summer-autumn (Gherardi *et al*. 1996). The medium wool hoggets were born in July/August and were less mature than their fine wool counterparts, the Wellstead and Denbarker hoggets which were born in April/May.

In contrast, the intercepts of the relationships for the adults indicated that it was only necessary to maintain liveweight over summer-autumn to produce wool >32 N/ktex. In fact, at liveweight maintenance the adults selected phenotypically for high staple strength produced wool of 56 N/ktex. These adults would be able to lose weight at 100 g/day and still be able to produce wool of >32 N/ktex. In general, adults are better buffered against the decline in the quantity and quality of the feed on offer during summer-autumn than young sheep.

In sharp contrast to the clear set of relationships described in this paper, on-farm studies conducted in 1994/95 and 1995/96 on 40 commercial flocks of hoggets born in autumn and shorn in spring demonstrated no relationship between the mean flock LWC over summer-autumn and the mean flock staple strength (C.M. Oldham, pers. comm). It is clear that the situation on farms is more complex, but an analysis of the data suggests that there are no obvious farm or management factors that could be used to create families of lines relating LWC and staple strength.

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