THE EFFECT OF STOCKING RATE ON FIBRE DIAMETER, STAPLE STRENGTH AND WOOL WEIGHT IN HIGH AND LOW FIBRE DIAMETER WOOL SHEEP ON CLOVER BASED PASTURES

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SUMMARY

A trial involving both high and low fibre diameter wethers at 9 different stocking rates on clover and phalaris pasture was established to investigate the effects of stocking pressure on staple strength. The results showed low staple strength in both genotypes at stocking rates greater than 9.5 dse/ha. Staple strength varied with stocking pressure and supplementary feeding from 36-9.1 N/ktex in low fibre diameter sheep and from 38.2-9 N/ktex in high fibre diameter sheep. The position of the break occurred at a similar time on all stocking rates and was close to the time of the break of the season. Strong relationships were found between staple strength and minimum liveweight and minimum fibre diameter. Change in fibre diameter appeared to be more detrimental to staple strength in high than in low fibre diameter sheep.

Keywords: staple strength, stocking rate, fibre diameter, liveweight.

INTRODUCTION

Staple strength of Merino wool is a major problem in mediterranean environments due to the large variation in feed supply throughout the year. Evidence of the importance of staple strength is provided in data from South Australia which showed that this state alone produced 24 million kg of tender wool in 1991/92. To enable better sheep management systems to be developed more knowledge was needed on the effect of annual changes in feed supply on liveweight changes and staple strength in genotypes of differing fibre diameters. To obtain this information low and high fibre diameter wethers were set stocked together at 9 different stocking rates to enable examination of different feed supply situations on these interactions.

The majority of wool produced in South Australia is grown under a mediterranean type of climate. The wet winters and dry summer/autumn periods result in a feed supply characterised by deteriorating feed quality over the summer/autumn period until the break of the season in late autumn/early winter. The resultant changes in wether liveweight are associated with large changes in fibre diameter and staple strength.

There has been debate about whether minimum fibre diameter or rate of change of fibre diameter is most important in affecting staple strength. Bigham *et al* (1983) have suggested that the minimum fibre diameter was the major cause of poor staple strength whereas Hansford and Kennedy (1988) concluded that the rate of change along the fibre was more important. Ritchie and Ralph (1990) found that between 70 and 80% of the variation in staple strength could be explained by the coefficient of variation of fibre diameter within a sample when the measurements of staple strength and fibre diameter were done on snippets taken by minicore of mid side samples of the sheep. Hynd (1992) suggests that the rate of growth of length to cross sectional area may also influence staple strength. From these papers it is apparent that there are possibly a number of factors controlling staple strength. The aim of this experiment was to investigate the relationship between stocking pressure and staple strength in high and low fibre diameter sheep.

MATERIALS AND METHODS

The treatment area situated in the lower south east of South Australia was sown to a mixture of Palestine strawberry clover *(Trifolium fragiferium*), Kyambro Persian clover *(Trifolium resupinatum),* Sirosa Phalaris (*Phalaris aquatica)* and Clare subterraneum clover (*Trifolium subterraneum)* on 26 May 1988. This pasture was grazed at a stocking rate of 12 dse/ha during 1990. During 1991 the area was fenced into 9 plots and stocked at rates of 6.2, 8, 9.5, 11.2, 13, 14.7, 16.5, 18.4 and 20 dse/ha with 1.5 year old wethers. Wethers were allocated to plots on the basis of wool weight, liveweight and fibre diameter after shearing in December 1991. In December 1991, 6 low fibre diameter (Victorian fine wool) and 6 high fibre diameter (South Australian strong **wool)** wool sheep were placed on each plot and the stocking rates were achieved by varying the size of the plots. Liveweights, body condition scores and wool lengths of the wethers were recorded every month and a dye band placed in the wool on the midside of each wether every second month. Wethers were cobalt bulleted at the beginning of the trial and received 2 summer drenches with Ivomec. Supplementary feeding was given for survival only and commenced when the average liveweight of wethers on any plot went below 36 kg. This resulted in supplementary feeding levels of 8, 18, 8, 26, 43 and 45 kg/hd of a 90% oats, 10% lupin mix to the 9.5, 13, 14.7, 16.5, 18.4 and 20 dse/ha stocking rates respectively.

Greasy wool weight of the total fleece was measured in December when the dye banded samples and midside samples were also collected. Using the midside samples, yield was measured, staple strength was measured on the ATLAS machine, staple length from the skin to the tip of the staple was measured with a ruler, average fibre diameter of the staple was measured using fibre fineness distribution analysis on minicore samples, and the position of break in the staple was measured by manually breaking a staple. The average fibre diameters of the wool grown between each dye band was also measured by fibre fineness distribution analysis on minicore samples.

The relationships between the various parameters measured were analysed using simple linear regression after pooling of the data for all stocking rates. The relationships between the high and low fibre diameter sheep were analysed separately.

RESULTS

Results of all wool parameters measured on midside samples and dye band samples for both of the genotypes are shown in Tables l-4. There was a significant effect ($P < 0.001$) of stocking rate on greasy wool weight and average fibre diameter for both groups. The R^2 values for the stocking rate effect on greasy wool weight were 0.28 and 0.27, and on average fibre diameter were 0.34 and 0.23, for the low and high fibre diameter sheep respectively. Wool tenderness problems occurred at stocking rates of 9.5 dse/ha and above. This tenderness, as indicated by the position of the break, occurred at about the same time across all stocking rates. This was determined by comparing the mean position of the break with mean wool lengths on 7 April 1992 (Tables 1 and 2).

Table 1. Greasy fleece weight (GFW), average fibre diameter (FD), yield, length, staple strength, position of break (Break) and wool length on 7 April 1992 (WL) for low fibre diameter wethers at different stocking rates

Wool characteristic	Stocking rates (dse/ha)								
	6.2	8.0	9.5	11.2	13.0	14.7	16.5	18.4	20.0
GFW (kg)	5.2	4.8	4.9	5.0	5.0	4.9	4.8	4.1	3.8
Average FD (μm)	22.1	20.0	19.9	21.3	20.3	20.0	19.6	19.1	18.4
Yield (%)	75.5	75.4	73.1	78.0	75.4	70.8	74.7	73.1	72.9
Length (mm)	96	104	103	105	110	90	102	98	101
Strength (N/ktex)	36.0	25.7	15.1	27.0	12.7	9.1	14.4	15.7	19.7
Break (mm from tip)		32	34	40	35	32	34	33	33
WL 7/4/92 (mm from tip)	36	36	35	38	35	30	33	30	32

The relationship between mean fibre diameter during different periods and staple strength was examined by linear regression of the means of each stocking rate on staple strength for high and low fibre diameter sheep separately. The highest level of fibre diameter significance was for the period between 13 February and 7 April 1992. The equations describing the relationships between staple strength (SS) and mean fibre diameter (μm) for this period for high and low fibre diameter sheep were $SS = -97.05\ (\pm 35.6) + 5.3\ (\pm 1.67)\mu m$, $R^2 = 0.60$, $P < 0.05$, $n = 9$ and $SS = -75.2\ (\pm 25.4) + 5.2\ (\pm 1.4)\mu m$, $R^2 = 0.67$, $P < 0.01$, $n = 9$ respectively. This period was also that of minimum fibre diameter along the staple.

The relationship between liveweight (Wt) and staple strength was examined in the same manner. The liveweight on 7 April 1992 showed the strongest relationship with staple strength. The equations for the high and low fibre diameter sheep were $SS = 34.5\ (\pm 8.8) + 1.24\ (\pm 0.21)Wt$, $R^2 = 0.84$, $P < 0.05$, $n = 9$ and $SS = 24.1\ (\pm 9.4) + 1.29\ (\pm 0.3)Wt$, $R^2 = 0.76$, $P < 0.01$, $n = 9$ respectively. This was also the date of minimum liveweight.

The relationship between fibre diameter change and staple strength was also examined. The fibre diameter change between 6 December and 13 February and 13 February and 7 April 1992 was the largest and this was also the period of fibre diameter change most strongly associated with staple strength. The

Table 2. Greasy fleece weight (GFW), average fibre diameter (FD), yield, length, staple strength, position of break (Break) and wool length on 7 April 1992 (WL) for high fibre diameter wethers at different stocking rates

Wool characteristic	Stocking rates (dse/ha)								
	6.2	8.0	9.5	11.2	13.0	14.7	16.5	18.4	20.0
GFW (kg)	7.3	6.8	7.1	7.5	7.0	7.4	6.8	6.1	6.0
Average FD (μm)	25.6	24.2	25.0	25.9	25.2	24.8	24.5	22.9	22.9
Yield (%)	75.0	71.4	76.0	73.7	73.7	73.0	72.0	75.1	72.9
Length (mm)	128	117	124	127	124	126	131	123	115
Strength (N/ktex)	38.2	34.2	10.7	19.1	9.8	9.7	9.0	11.7	16.0
Break (mm from tip)		45	42	43	39	41	40	39	38
WL 7/4/92 (mm from tip)	47	45	41	44	39	39	40	37	38

equations describing the relationship between staple strength and fibre diameter change ($\Delta\mu m$) for high and low fibre diameter sheep for this period were $SS = 41.8(\pm 4.1) - 8.5(\pm 1.3)\Delta\mu m$, $R^2 = 0.85$, $P < 0.001$, $n = 9$ and $SS = 40.0(\pm 6.7) - 9.4(\pm 2.9)\Delta\mu m$, $R^2 = 0.6$, $P < 0.05$, $n = 9$ respectively.

Table 3. Fibre diameter measurements for wool grown between two-monthly dye bands for low fibre diameter wethers at different stocking rates

Period	Stocking rates (dse/ha)								
	6.2	8.0	9.5	11.2	13.0	14.7	16.5	18.4	20.0
6/12-13/2	22.0	20.3	20.0	21.3	20.0	19.9	20.7	19.9	19.1
13/2-7/4	20.7	18.9	18.0	19.8	17.7	17.8	17.3	17.1	16.6
7/4-12/6	22.6	20.6	19.9	20.8	20.1	19.3	19.8	17.9	18.0
12/6-29/7	22.5	20.1	21.8	21.2	21.7	20.6	20.9	20.2	19.5
29/7-29/9	23.3	20.4	22.1	22.0	21.7	20.8	21.8	20.1	19.5
29/9-16/12	22.7	19.8	21.8	22.1	21.8	20.9	21.5	20.5	19.7

Table 4. Fibre diameter measurements for wool grown between two-monthly dye bands for high fibre diameter wethers at different stocking rates

Period	Stocking rates (dse/ha)								
	6.2	8.0	9.5	11.2	13.0	14.7	16.5	18.4	20.0
6/12-13/2	25.1	23.4	25.2	24.9	24.0	24.6	23.9	23.0	23.2
13/2-7/4	24.1	22.3	21.5	23.1	19.9	20.6	20.8	19.5	19.8
7/4-12/6	26.4	24.7	24.4	26.1	24.3	23.8	24.2	23.3	21.6
12/6-29/7	26.7	25.2	27.1	27.7	26.6	26.9	26.7	25.4	24.2
29/7-29/9	26.8	25.0	27.6	28.2	27.2	27.7	27.2	25.3	25.2
29/9-16/12	25.9	24.6	27.3	27.0	27.0	27.7	27.0	25.1	24.2

The relationship between the weight of the wethers at the time of their lowest liveweight (Wt, 7 April 1992) on fibre diameter in the period prior to that weighing was also found to be highly significant for both genotypes. The equations for the high and low fibre diameter wethers were $\mu m = 13.8(\pm 1.3) + 0.2(\pm 0.03)Wt$, $R^2 = 0.84$, $P < 0.001$, $n = 9$ and $\mu m = 10.8(\pm 1.0) + 0.2(\pm 0.03)Wt$, $R^2 = 0.9$, $P < 0.001$, $n = 9$ respectively.

For both high and low fibre diameter sheep the value of wool length divided by average fibre diameter for each sheep was calculated. This value was then analysed to determine whether there was **any** relationship with staple strength. No significant relationship was found in either group.

Because of space restrictions only those relationships which were considered of importance to improving our understanding of staple strength problems have been reported on.

DISCUSSION

Minimum liveweight, minimum fibre diameter and maximum change in fibre diameter were all implicated in the staple strength problems exhibited in this experiment. The finding that the position of break was at about the same time across all stocking rates may have been associated with the opening rains in 1992 which occurred on 14 April.

Although the break in the wool occurred at much the same time in all wethers there were still strong relationships between staple strength and liveweight, fibre diameter change and fibre diameter. The only difference between the high and low fibre diameter wethers in regards staple strength was the greater susceptibility of the high fibre diameter sheep to fibre diameter change.

These findings suggest that the attainment of maximum wool production and profitability, both of which occurred at a stocking of 14.7 dse/ha for both genotypes, is not achievable in this district without severe staple strength problems under set stocking conditions. The obvious solution is of course to shear during the March/April period. Other factors such as grass seeds and fly strike problems dissuade producers from adopting this strategy. Other solutions may be to supplementary feed commencing soon after feed quality begins to decline, rather than waiting until liveweight has declined to levels which are associated with wool tenderness, or rationing feed supply to prevent large liveweight changes.

The relationships between stocking rate and wool weight and fibre diameter, although strongly significant, did not explain as much of the variation as expected, probably due to large amounts of supplementary feeding at the higher stocking rates.

This study reports only the first year's data. During the next 3 years ways of overcoming staple strength problems will be evaluated.

REFERENCES

BIGHAM, M.L., SUMMER, R.M.W., HAWKER, H. and FITZGERALD, J.M. (1983). *Proc. N.Z. Soc. Anim. Prod. 43: 74.*

HANSFORD, K.A. and KENNEDY, J.P. (1988). *Proc. Aust. Soc. Anim. Prod.* **17: 415.**

HYND, P.I. *(1992). Proc. Aust. Soc. Anim. Prod.* **19: 152.**

RITCHIE, A.J.M. and RALPH, I.G. *(1990). Proc. Aust. Soc. Anim. Prod.* **18: 543.**