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Seasonality of wool growth in Waikato and Southland of Romney sheep selected for high fleece weight

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ABSTRACT

Wool growth rate was estimated for a total of 525 Romney ewes born in 1991 and 1992 between 5 and 28 months of age. Both year born groups contained sheep from three flocks selected over an extended period for increased hogget fleece weight and their respective Control flock. One flock was located in the Waikato, one in Southland and one split between the two locations. Following adjustment for live weight the seasonality of wool growth rate in Southland was significantly greater than in the Waikato reflecting the sensitivity of Romney sheep in recognising small changes in the length of daylight between the two locations. Selection for increased hogget fleece weight resulted in a greater increase in relative wool growth rate during the winter than during the summer.

Keywords: Romney; seasonality; day length; selection; wool growth rate.

INTRODUCTION

Sheep exhibit a seasonal cycle in wool growth associated with concomitant changes in fibre length growth rate, mean fibre diameter and mean fibre volume. The cycle which is under endocrine control entrained by the annual photoperiod (reviewed by Sumner and Bigham, 1993) has a maximum in summer and a minimum in winter. Wool growth rate can be influenced directly by variations in feed intake and indirectly by seasonal variations in pasture quantity and quality (Hawker, 1985). Breeds vary in the amplitude of their respective cycles (Bigham *et al.*, 1978). No published estimates of the effect of seasonal variation in day length over the length of New Zealand on the relative seasonality of wool growth for genetically similar groups of sheep are known to the authors.

In February 1992 a flock of Romney sheep, selected for increased hogget fleece weight since 1973 (Clarke line) and their randomly bred Romney Control (Clarke, 1974) was split between Woodlands Research Station (near Invercargill) at Latitude 46 22S and Tokanui Research Station, (near Te Awamutu) at Latitude 38 07S. This provided an opportunity to quantify the magnitude of the potential latitude effect on wool growth that may apply to Romney type sheep within New Zealand. Sheep in the Clarke flock and its Control flock grazing at Woodlands were run with another high fleece weight Romney flock (Hawker flock) and its Control established in the early 1980's by screening in high fleece weight hoggets from a number of large industry flocks (Hawker and Littlejohn, 1986). Following the transfer of half of each of the Clarke Selected and Control flocks to Tokanui, the transferred group were run in association with a further high fleece weight line selected for increased hogget fleece weight since 1969 (Hight line) and their Control flock (Johnson *et al.*, 1995). Consequent upon this relocation it was possible to simultaneously compare selection flocks and their con-

trols for seasonality of wool growth at two locations differing in daylength. This paper reports the results of that study.

MATERIALS AND METHODS

Data were collected from a total of 525 ewes born in 1991 ($n = 231$) and 1992 ($n = 294$) according to a factorial design involving two locations (Tokanui and Woodlands), three flocks (Clarke and Hight at Tokanui, and Clarke and Hawker at Woodlands) and two lines (Selected and Control for each flock at each location). The numbers of sheep in each treatment cell are indicated in Table 2. All sub-groups of a similar age at each location were grazed together for the duration of the trial. Each drop of ewes were withheld from mating during their second year on the trial.

Each sheep was live weighed and a midside patch area clipped at approximately 6 weekly intervals for 23 months from 5 months of age. Ewes born in 1991 were sampled between February 1992 and November 1993 and the ewes born in 1992 were sampled between February 1993 and December 1994. The clipped patch samples were washed individually and the total weight of clean wool harvested from each patch calculated. Each drop of ewes were shorn as lambs in December when 3 months old, in October when 13 months old (hogget shearing), in February when 17 months old (2-tooth pre-mating shearing) and in December when 27 months old (ewe shearing at weaning). Individual greasy fleece weights were recorded at the hogget, 2-tooth and ewe shearings and a midside fleece sample taken for measurement of washing yield to calculate clean fleece weight. Individual clean wool growth rate during each period was estimated by proportioning each ewe's clean fleece weight according to the relative weight of clean wool clipped from her midside patch during that period.

Individual estimates of wool growth rate declined from the start of the trial to a minimum during the first

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winter, increased to a maximum during the ensuing summer before declining again to a second minimum the following winter. These stages of the wool growth cycle are subsequently referred to as Min1, Max and Min2 respectively.

Smoothed curves were fitted to the live weight and wool growth rate data of each sheep using a Bayesian smoothing procedure (Upsdell, 1994) from which were derived estimates of values for live weight and wool growth rate at Min1, Max and Min2 and also the calendar day for Min1, Max and Min2. As the trial encompassed two periods of minimal growth but only one period of maximal wool growth, estimates of wool growth rhythm calculated in a similar manner to the estimates of Sumner *et al.* (1994) would have been confounded as each half of the wool growth cycle contains a common estimate of maximal wool growth. A single alternative measure of seasonality, subsequently referred to as relative wool growth amplitude, was calculated as:- ((Wool growth rate at Max) - ((Wool growth rate at Min1 + Wool growth rate at Min2) / 2)) / (((Wool growth rate at Min1) + (2 x Wool growth rate at Max) + (Wool growth rate at Min2)) / 4).

The calendar day of Min1, Max and Min2, live weight at Min1, Max and Min2, wool growth rate at Min1, Max and Min2 and relative wool growth amplitude, were each analysed by regression procedures. The model included main effect terms of location, flock and line, with between year effects included in the error. Wool growth rate at Min1, Max and Min2, and relative wool growth amplitude were each analysed, with and without adjustment for live weight at that and each preceding time assuming live weight to be an indicator of variations in feed quantity and quality between the two locations.

RESULTS

Tokanui experiences 60 minutes less daylight (time from sunrise to sunset) at the summer solstice and 56 minutes more daylight at the winter solstice than Woodlands (Table 1). Climatic conditions also vary between the two sites. While Tokanui has a higher mean annual rainfall (1257 mm) than Woodlands (1041 mm), 23% of the rain falls in the summer and 30% in the winter at Tokanui whereas 31% of the mean annual rainfall at Woodlands falls in the summer and only 22% in the winter (Stockpol database, Marshall *et al.*, 1991). Mean monthly air temperature at Tokanui is 4.4 °C warmer in summer and 2.5°C warmer in winter than at Woodlands (Stockpol database, Marshall *et al.*, 1991). In combination, these climatic

TABLE 1: Duration of daylight during the summer and winter solstice at Tokanui and Woodlands Research Stations (H.M. Nautical Almanac Office, 1996).

Location	Duration of daylight	
	22 Dec h	22 June h
Tokanui	14:49	9:31
Woodlands	15:49	8:35

effects result in an average total annual pasture production of 15,930 kgDM/ha at Tokanui and 12,303 kgDM/ha at Woodlands with a different seasonal pattern (Stockpol database, Marshall *et al.*, 1991). Pasture growth rates tend to be equivalent at the two sites during January (50.0 vs 53.1 kgDM/ha/d respectively) but the pasture growth rate at Tokanui is approximately double that at Woodlands during July (21.0 vs 9.7 kgDM/ha/d respectively).

The mean day of Min1 was 171 ± 1 (20 June) and did not differ significantly between locations, flocks or lines. Sheep at Woodlands were 14 ± 2 days later attaining their maximum rate of wool growth on day 17 ± 1 (17 January) and 11 ± 2 days later in reaching Min2 on day 224 ± 1 (12 August) compared with the sheep at Tokanui. The date of Max and Min2 did not differ significantly between flocks or lines.

TABLE 2: Number of sheep in each location, flock and line cell and adjusted mean live weight and wool growth rate for each sheep at the time of their first minimum, maximum and second minimum period of wool growth.

Treatment	No of sheep	Live weight (kg)			Wool growth rate (g/d)		
		Min1	Max	Min2	Min1	Max	Min2
<i>Location:</i>							
Tokanui	188	34.3	42.5	50.7	6.6	13.8	8.1
Woodlands	337	31.4	45.1	49.8	5.4	15.1	4.7
LSD		0.9	1.1	1.1	0.2	0.4	0.3
Signif.		***	***	*	***	***	***
<i>Flock:</i>							
Clarke	224	31.1	42.1	48.4	5.8	14.7	5.7
Hawker	205	34.7	47.4	53.4	5.9	14.8	6.1
Hight	96	30.9	41.7	47.3	5.9	13.9	6.0
LSD		1.4	1.4	1.7	0.2	0.4	0.3
Signif.		**	**	**	NS	*	NS
<i>Line:</i>							
Selected	267	34.5	46.4	52.8	6.5	15.9	6.6
Control	258	30.4	41.7	47.4	5.2	13.3	5.3
LSD		0.7	0.8	1.0	0.2	0.3	0.2
Signif.		***	***	***	***	***	***

* p<0.05; ** p<0.01; *** p<0.001.

The number of sheep in each of the location, flock and line, treatment cells and mean live weight at Min1, Max and Min2 are given in Table 2. Sheep at Tokanui were heavier in the winter but lighter over the summer, than the sheep at Woodlands reflecting the amount and quality of available pasture. The Hawker flock were consistently heavier than the other two flocks which were not significantly different and the Selected lines were consistently heavier than the Control lines. All interaction terms for live weight and wool growth rate at Min1, Max and Min2 were not significant. On average 57% of the variation in wool growth rate at Min1, Max and Min2 was explained by the main effects within the model. Inclusion of the live weight terms explained a further 15% of the total variation. The large increase in explained variation through the inclusion of live weight in the model is indicative of the

effectiveness of live weight as an appropriate variate to adjust wool growth rate for variation in the amount and quality of available pasture. Mean wool growth rates adjusted for live weight for each of the main effects at Min1, Max and Min2 are included in Table 2. Sheep at Tokanui had higher wool growth rates than sheep at Woodlands at both winter minima but a lower wool growth rate at the summer maximum. Wool growth rates of the three flocks at the two minima were not significantly different while the adjusted growth rate of the Hight flock at their maximum was significantly less than the wool growth rate of the Clarke and Hawker flocks which were not significantly different. The increases in wool growth rate achieved through selection, expressed as a proportion of wool growth rate in the Control lines, were higher in winter than in summer ($p < 0.001$). Relative growth rate was 26% at Min1 and 25% at Min2 in the winter but only 19% at Max in the summer.

There was a significant interaction ($p < 0.05$) between location and line, and between flock and line for the calculated relative wool growth amplitude. Mean values of the calculated relative amplitude for the two way terms are given in Table 3. While the relative wool growth amplitude did not differ significantly between the Selected and Control lines at Tokanui, the Control lines displayed a significantly greater amplitude than the Selected lines at Woodlands. Overall the Hight flock exhibited a lower relative amplitude than the Clarke and Hawker flocks which were not significantly different. There was a greater reduction in amplitude for the Hight Selected line than for the Hight Control line.

TABLE 3: Mean relative wool growth amplitude adjusted for live weight.

Treatment Line	Location		Flock		
	Tokanui	Woodlands	Clarke	Hawker	Hight
Selected	0.61	0.96	0.87	0.85	0.74
Control	0.60	1.03	0.90	0.86	0.87
LSD	0.04		0.04		
Signif.	*		*		

* $p < 0.05$.

DISCUSSION

The measure of seasonality of wool growth rate reported by Sumner *et al.* (1994) and the measure used in this paper are equivalent. Each is a ratio of the difference between seasonal maxima and minima, divided by the mean growth rate over the time period concerned. The relationship has value in enabling quantitative comparisons to be made between genotypes and locations.

As well as being the first paper to report latitude effects on wool growth this is also the first paper to report relative difference in live weight and wool growth between the three Romney flocks selected for increased hogget fleece weight over an extended period on New Zealand Government Research Stations. The patterns of

seasonality in wool growth observed here were broadly similar to those previously reported for Romney sheep in various individual trials in the Waikato and in Southland (Bigham *et al.*, 1978; Hawker, 1985; Wuliji *et al.*, 1993).

As previously reported for each flock individually (Clarke, 1983; Hawker *et al.*, 1988; Morris *et al.*, 1996) there was a consistent positive relationship between fleece weight and live weight with the Selected ewes being heavier than the Control ewes.

Earlier trial work at Woodlands has demonstrated that responses of wool growth to changes in level of nutrition in summer are approximately twice those achieved in winter with similar changes in nutrition (Hawker and Crosbie, 1985). The magnitude of the season by location interaction in adjusted wool growth rate and the small delay in attaining Max and Min2 at Woodlands relative to Tokanui, indicates there may still be residual effects associated with pasture quality or other physiological responses impacting on wool growth independently of live weight. These trends serve to highlight the practical difficulties associated with adjusting wool production data for possible environmental influences across mobs and/or locations. Nevertheless the difference in seasonality of adjusted wool growth between the two locations indicates physiological control mechanisms regulating wool growth (Nixon *et al.*, 1998) are able to respond to a difference of an hour in the duration of daylight in winter and summer.

As ambient temperature has only a limited effect on wool growth (Hutchinson and Bennett, 1963) the small temperature difference between Tokanui and Woodlands is unlikely to directly impact on wool growth rate.

With changes in wool growth rate reflected in changes in both fibre diameter and staple length (Hawker and Crosbie, 1985), the greater seasonality in Southland emphasises that farmers in this area should be shearing close to the minimum period of wool growth, to minimise the incidence of unsoundness within their clips. This will however increase the risk of post-shearing mortality.

Lack of a location by line interaction for wool growth rate, indicates that the genetic gains in fleece weight achieved through selection for increased hogget fleece weight at one location are expressed similarly at other locations, regardless of the season of the year. However relative wool growth amplitude has apparently changed as a result of the imposed selection policies. Overall the Hight flock had a lower seasonality than the other two flocks and the Hight Selection line had a lower seasonality than the Control line. Both the Selected lines at Woodlands grew significantly more wool during the winter trough than the Control lines, confirming trends evident in recent analyses of the late Hugh Hawker's data (J. N. Clarke, unpublished) at Woodlands and data reported by Wuliji *et al.* (1993).

CONCLUSION

This trial has served to confirm, using a common genotype at two locations in New Zealand with a differing duration of daylight, that wool growth in the Romney is significantly influenced by length of daylight and nutri-

tion. Selection for increased hogget fleece weight in three separate flocks has resulted in similar responses in live weight and fleece weight. Wool growth amplitude however, has apparently changed as a result of the imposed selection policies.

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REFERENCES

- Bigham, M.L., Sumner, R.M.W. and Elliott, K.H. 1978. Seasonal wool production of Romney, Coopworth, Perendale, Cheviot and Corriedale wethers. *New Zealand Journal of Agricultural Research* **21**: 377-382.
- Clarke, J.N. 1974. Selection in Romney, Cheviot and Border Leicester sheep. In Annual Report of Agricultural Research Division of the New Zealand Ministry of Agriculture and Fisheries. 1973-74. p. 210-211.
- Clarke, J.N. 1983. Selection in Romney sheep. In Annual Report of Agricultural Research Division of the New Zealand Ministry of Agriculture and Fisheries. 1982-83. p. 258.
- H.M. Nautical Almanac Office, 1996. The Nautical Almanac 1997, HMSO, London. pp. 363.
- Hawker, H. 1985. Effects of season and nutrition on wool growth. In Proceedings of Wool Production Seminars, New Zealand Wool Board. Chapt. 4, p. 1-13.
- Hawker, H. and Crosbie, S.F. 1985. Effects of level of nutrition in winter and summer on the wool growth of Romney and Perendale ewes with a history of high and low winter wool growth. *Proceedings of the New Zealand Society of Animal Production* **45**: 225-228.
- Hawker, H., Dodds, K.G., Andrews, R.N. and McEwan, J.C. 1988. Production and characteristics of wool from the hogget progeny of sheep intensively screened for fleece weight. *Proceedings of the New Zealand Society of Animal Production* **48**: 207-212.
- Hawker, H. and Littlejohn, R.P. 1986. Live weights, fleece weights and wool characteristics of screened high fleece weight and randomly selected Romney ewe hoggets. *Proceedings of the New Zealand Society of Animal Production* **46**: 219-223.
- Hutchinson, J.C.D. and Bennett, J.W. 1963. Temperature and wool growth. *Proceedings of the Australian Physiological Society*. August 1963: 16.
- Johnson, D.L., Hight, G.K., Dobbie, J.L., Jones, K.R. and Wrigglesworth, A.L. 1995. Single trait selection for yearling fleece weight or liveweight in Romney sheep-direct responses. *New Zealand Journal of Agricultural Research* **38**: 115-122.
- Marshall, P.R., McCall, D.G. and Johns, K.L. 1991. Stockpol: A decision support model for livestock farms. *Proceedings of the New Zealand Grasslands Association* **53**: 137-140.
- Morris, C.A., Johnson, D.L., Sumner, R.M.W., Hight, G.K., Dobbie, J.L., Jones, K.R., Wrigglesworth, A.L. and Hickey, S.M., 1996. Single trait selection for yearling fleece weight or liveweight in Romney sheep-correlated responses in liveweight, fleece traits, and ewe reproduction. *New Zealand Journal of Agricultural Research* **39**: 95-106.
- Nixon, A.J., Choy, V.J., Ford, C.A. and Pearson, A.J. 1998. Prolactin receptors are highly expressed in wool follicle dermal papillae. *Proceedings of the New Zealand Society of Animal Production* **58**: This volume..
- Sumner, R.M.W. and Bigham, M.L. 1993. Biology of fibre growth and possible genetic and non-genetic means of influencing fibre growth in sheep and goats-a review. *Livestock Production Science* **33**: 1-29.
- Sumner, R.M.W., Clarke, J.N., Pearson, A.J. and Speedy, P.M. 1994. Repeatability of seasonal wool growth in Merino sheep. *Proceedings of the New Zealand Society of Animal Production* **54**: 163-165.
- Upsdell, M.P. 1994. Bayesian smoothers as an extension of nonlinear regression. *The New Zealand Statistician* **29(2)**: 66-81.
- Wuliji, T., Weatherall, I.L., Andrews, R.N., Dodds, K.G., Turner, P. and Wheeler, R. 1993. Comparisons of seasonal wool growth pattern and colour variation in fleece weight selected and control Romney flocks. *Proceedings of the New Zealand Society of Animal Production* **53**: 351-354.