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A comparison of internal parasitism in fleeceweight-selected and control Romney sheep

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ABSTRACT

This trial was designed to test the hypothesis that increased faecal egg counts (FEC) of fleeceweight-selected (FW) lambs over control (C) lambs represented a decreased resistance to internal parasitism in FW lambs. Measurements were recorded over a 42 day period from late February 1991 using August-born lambs from the Massey University FW and C flocks. All lambs were drenched with ivermectin on day 0. Lambs of each sex and flock were randomly allocated within sire (4 per flock) to receive an albendazole controlled release capsule (+ALB), or remain undrenched (-ALB). Ewes and rams were run separately. Midside wool growth, liveweight, and FEC were recorded, and estimates of dry matter intake were inferred from chromate analyses.

The FW lambs had consistently higher FEC's than C lambs. Significant differences were observed by flock and ALB treatment in both wool production and liveweight gain, but no significant flock-by-ALB interactions were detected. Trends in production traits indicated that the superiority of FW lambs may have increased in situations where the development of adult worm burdens was continually suppressed. However, no clear evidence was found to show that FEC is a reliable indicator of a sheep's resistance to production losses arising out of internal parasitism.

Keywords Lambs, internal parasites, faecal egg count, liveweight gain, wool production.

INTRODUCTION

Parasitism by gastro-intestinal (GI) parasites poses a major economic cost to sheep farmers. Production losses arising out of subclinical infections are of greatest significance. A loss of appetite, and associated depressions in body and wool growth often occur in animals affected with such infections.

In the past, the administration of anthelmintic drenches and grazing strategies to provide safe feed (uncontaminated pasture) have been used to control the effects of internal parasitism. In practice, limitations imposed by geography, climate, and seasonal patterns of feed demand have meant that farmers have often not been able to generate the safe feed required. Further, the steady development of parasite populations resistant to the three commonly used families of anthelmintic drench has resulted in more permanent solutions to the problem of internal parasitism in sheep being sought.One solution is breeding sheep which are genetically resistant to internal parasitism. Ideally sheep which are selected for increased resistance to internal parasitism will suffer reduced production losses when subclinically parasitised. A number of criteria have been investigated as possible markers of resistance. Albers *et al.*, (1987) defined the ability of an animal to maintain a relatively undepressed level of production when parasitised as "resilience". Using 3-5 month old merino wethers artificially infected with *Haemonchus contortus* larvae, they found that resilience in both wool growth and liveweight gain (LWG) had a low heritability. It was concluded that direct selection for resilience would result in slow rates of improvement in resistance to parasitism.

A further group of selection criteria seek to increase resistance to internal parasitism by increasing the sheep's ability to retard the development and/or reproduction of internal parasites in the GI tract. These have been reviewed by Gray (1991) and Windon (1991). Of the wide variety of criteria available faecal egg count (FEC), which measures the number of nematode eggs being excreted in sheep's faeces, remains the most widely accepted criteria for selecting sheep resistant to internal parasitism. A lower FEC is taken to indicate increased resistance.

Studies have shown that genetic variation in FEC exists in non-lactating mature animals (Stewart *et al.*, 1937; Gregory *et al.*, 1940), in lactating ewes (Donald *et al.*, 1982; Courtney *et al.*, 1984) and in lambs yet to fully develop an acquired immunity to internal parasites (Baker *et al.*, 1990; Woolaston, 1990). Lambs offer the greatest attraction for a breeding programme, as selection differentials are likely to be greater, and generation intervals reduced compared with other alternatives. Heritability estimates for FEC in lambs have been of the order of 0.3-0.4 (Piper, 1987). Selection experiments have successfully established genetic divergence in FEC between lines in Australia (Woolaston, 1990) and New Zealand (Baker *et al.*, 1990) demonstrating the feasibility of such breeding programmes. Further, juvenile-mature genetic correlations for FEC appear to be high (Woolaston and Gray, 1991).

The value of FEC as a selection criterion to achieve reduced production losses in subclinically parasitised animals remains to be demonstrated. Selection for reduced FEC will result in a reduction in the faecal egg output of sheep, and thus a reduction in the level of pasture contamination with infective larvae. However, sheep will still be ingesting larvae when grazing, and unless selection for reduced FEC has also resulted in decreased production losses arising out of internal parasitism, then little economic benefit to the farmer has been gained. Albers *et al.*, (1987) found that a strong, positive, genetic correlation existed between FEC and resilience. However, this was based on a trial conducted over a relatively short period of time. Few other workers have addressed this issue, and based on work published to date no firm conclusions about the value of FEC in this context can be drawn.

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Unpublished observations on lambs from the fleeceweight-selected (FW) and control (C) Romney flocks at Massey University (Blair *et al.*, 1984; 1985) demonstrated that FW lambs had higher FEC's than C lambs. The current trial was established to test the hypothesis that these observations represent a reduced resistance to internal parasitism in FW lambs, as a consequence of selection for high yearling greasy fleeceweight.

MATERIALS AND METHODS

Trial Specifications

The trial was carried out on the Ruminant Research Unit at Massey University over a 42 day period, commencing in late February, 1991. The animals used were August-born (1990) lambs from the Massey University FW and C Romney flocks. Lambs of the same sex from both FW and C flocks were grazed on pasture together as a single mob. Ram and ewe lambs were managed and run independently.

Prior to the trial the lambs had been weaned and managed according to normal farm practice. All lambs were drenched with ivermectin on day 0 to remove existing nematode worm burdens. Lambs from each flock were randomly allocated within sex and sire (4 sires per flock) into two treatment groups. One group (+ALB) received a controlled release capsule (CRC) containing albendazole. These capsules mimic continuous anthelmintic drenching, and suppressed the establishment of adult parasite burdens in the GI tracts of the lambs over the period of the trial. The other group (-ALB) was not drenched again during the 42 day period allowing nematode larvae to establish and mature in the GI tract.

Measurements Recorded

Faecal samples were taken on day 0, and day 12 to ensure that the ivermectin drench had successfully removed adult parasites from the gut. Further samples were taken at days 28 and 42 to monitor the development of subclinical parasitism in infected animals. A modified McMaster method where each egg counted represented 50 eggs per gram was used to estimate FEC's. All FEC's were expressed on the basis of eggs per gram of wet faeces for this report. Data were not transformed, as initial analyses indicated no statistical advantage in doing so.

A chromate CRC was administered to all lambs on day 21 to allow estimation of Dry Matter Intake (DMI). Faecal samples were obtained from lambs over 2 periods of 3 consecutive days during the trial (days 28-30, and 40-42). Analysis was by the method detailed by Costigan and Ellis (1987). Hand-plucked pasture samples were used to determine dry matter digestibility. This, combined with the results of laboratory faecal analysis, allowed calculation of DMI (Parker *et al.*, 1990). Results at 28 and 42 days were expressed as daily DMI (DMI_{28}, DMI_{42}) and daily DMI per unit of metabolic liveweight ($kg^{0.75}$) ($METDMI_{28}$, $METDMI_{42}$).

A midside patch was cleared from all lambs on day 0 and on day 42. The greasy and clean weights of the wool grown over the 42 day period were obtained under standard conditions (65% relative humidity, 20°C). Clean wool growth (CW) per unit area (g/100 cm^2) was obtained by dividing weight of wool by area of patch. Based on the relationship derived by Lines and Pierce (1931), 1 g/100cm^2 of CW represents approximately 92g and 99g of clean wool growth across the whole body of ewe and ram lambs, respectively.

All lambs were weighed immediately off pasture on days 0,12,21, 28 and 42.

Analysis Of Data

At the end of the trial data from 40 ewe lambs and 47 ram lambs were available for analysis. Data were analysed separately by sex, because management of the two sexes was different, and previous workers have suggested that the response to parasitism was different for ram and ewe lambs (Emik, 1949; Courtney *et al.*, 1985). Sire effects were not included in any of the models, as each experimental group contained lambs sired by all rams within line.

A fixed effect model was used in data analysis, including effects for flock, albendazole treatment and a flock-by-albendazole interaction. No covariates were significant in the analysis of FEC and DMI, but $METDMI_{42}$ was significant in the analyses of production traits (LWG, CW), and was retained as a covariate. A further fixed effects model was developed to test the relationship between FEC and measures of production and feed intake. All +ALB animals were excluded from these analyses, as their FEC's were suppressed by the albendazole released from the CRC.

RESULTS AND DISCUSSION

A major limiting factor in this trial was the small numbers of lambs present in each treatment group. Data from approximately 10 lambs of each sex per treatment were available for analysis, (this accounted for all available FW and C lambs born in 1990). Given the variation observed in many of the traits measured, these numbers were not sufficient to provide power to detect differences of less than one standard deviation.

Faecal cultures from both rams and ewes indicated about 80% of the eggs to be from *H. contortus.*

Faecal Egg Count:

Group mean FEC's for day 28 and day 42 are presented in tables 1 and 2.There was a significant difference in FEC between -ALB and +ALB lambs in all situations (P<0.1 for ram 28 day FEC; P<0.01 for ewe 28 day and 42 day FEC, and in ram 42 day FEC). The FECs of FW ewe lambs were marginally significantly different from C lambs at 28 days (P<0.1), and the difference between FW and C ram lamb FEC's at 42 days was approaching significance (P=0.13).

TABLE 1 28 day mean faecal egg counts (eggs/gram wet faeces) of fleeceweight-selected (FW) and control (C) lambs treated with albendazole (+ALB) and untreated (-ALB)

	Ewes			Rams		
	C	FW	Signf	C	FW	Signf
-ALB	885	2450		289	977	
			**			†
+ALB	5	25		0	0	
Signf	†			ns		
	PSE[a]=1351			PSE[a]=1027		

[a]PSE=pooled standard error

Drenching of lambs via albendazole CRC's produced a significant depression in FEC when compared with their undrenched contemporaries. The onset of a degree of self-cure was evident in -ALB FW ewe lambs as their mean FEC decreased towards the end of the trial. The FW lambs were consistently producing higher FEC's than C lambs, which confirms the previous observations made on lambs from these

TABLE 2 42 day mean faecal egg counts (eggs/gram wet faeces) of fleeceweight-selected (FW) and control (C) lambs treated with albendazole (+ALB) and untreated (-ALB).

	Ewes			Rams		
	C	FW	signf	C	FW	Signf
-ALB	1486	2206		1233	2650	
			**			**
+ALB	5	39		5	20	
Signf	ns			ns		
	PSE[a]=1236			PSE[a]=1459		

[a]PSE=Pooled Standard Error

flocks. The trend observed in these results, that sheep genetically superior for production traits have higher FEC's than other sheep, is consistent with the findings of Watson *et al.*, (1986) and with McEwan *et al.*, (1992) These results also support the findings reported by Woolaston (1990), and Cummins *et al.*, (1990) that FEC is positively genetically correlated with clean wool production.

Dry Matter Intake

No significant interaction between flock and ALB treatment in DMI was observed in this trial and no difference was found to exist either by flock or by ALB treatment. This is in contrast to the depressions in DMI of 10-20% in cases of subclinical parasitism reported previously (Sykes and Poppi, 1982).

As was discussed by Parker *et al.*, (1990), determination of DMI by chromate analysis includes a number of inherent errors, resulting from variation in chromate release rates and DM digestibility determination. In this trial chromate release rates and digestibilities were assumed to be constant within sex, across all treatment groups at each sampling date. While digestibilities will not be constant between the sexes (due to the independent management of ewes and rams) it is reasonable to ignore these errors for the purposes of analysis in this trial, as no between-sex or between-sampling date comparisons have been entered into.

Clean Wool Growth

Group means for CW are presented in Table 3. The interaction between flock and ALB was not significant in either sex. The CW of FW lambs was higher in both ewes ($P<0.1$) and rams ($P<0.01$). More wool was grown by +ALB ewe lambs than -ALB ewe lambs ($P<0.01$) but there was no significant ALB treatment effect in ram lambs. No significant relationship was observed between CW and $METDMI_{42}$. The relationships between FEC and CW within -ALB groups of both flocks were generally negative but none of these were significant at the 10% level.

The superiority of FW lambs over C lambs for CW when parasitised was not significantly different from when parasitism was being continuously controlled by the albendazole CRC's. A trend was observed towards such a relationship in ewe lambs, with FW superiority increasing from 7.5% to 16.9% between -ALB and +ALB treatments. No such trend was evident in FW ram lambs, with +ALB lambs actually appearing to produce less wool than -ALB. This result will need to be clarified in future work.Some doubt may be cast on the usefulness of CW observations obtained during this trial. Albers *et al.*, (1989) found that there was a 3-6 week lag between the administration of a dose of infective H. contortus larvae to lambs and the onset of wool growth depression. Given that the length of this trial was only 6 weeks, there are grounds to suggest that full expression of wool growth differences had not been achieved when midside samples were harvested on day 42. It may be of value to delay the harvest of samples for a longer period in future trials, so differences in wool growth can be more fully expressed.

TABLE 3 Clean mid-side wool growth over 42 days (g/100cm²) in fleeceweight-selected (FW) and control (C) lambs treated with albendazole (+ALB) and untreated (-ALB).

	Ewes			Rams		
	C	FW	Signf	C	FW	Signf
-ALB	5.4	5.8		5.0	6.5	
			**			ns
+ALB	5.9	6.9		5.6	6.1	
Signf	†			**		
	PSE[a]=1.2			PSE[a]=0.9		

[a]PSE = Pooled Standard Error

Liveweight Gain

Group Mean LWGs for the 42 day period are given in Table 4. Flock by ALB interactions were not significant in either sex. No significant flock or ALB effects were evident in ewe lamb LWG over the period. However, FW ram lambs grew significantly faster than C ram lambs ($p<0.05$), and +ALB ram lambs grew significantly faster than -ALB ram lambs ($p<0.01$). In both ewes and rams there was a significant positive relationship between $METDMI_{42}$ and LWG.

TABLE 4 Daily liveweight gain over 42 days (g/day) in fleeceweight-selected (FW) and control (C) lambs treated with albendazole (+ALB) and untreated (-ALB)

	Ewes			Rams		
	C	FW	Signf	C	FW	Signf
-ALB	65	71		65	71	
			ns			**
+ALB	89	101		105	143	
Signf	ns			*		
	PSE[a]=26			PSE[a]=31		

[a]PSE = Pooled Standard Error

There were highly significant ($p<0.01$) negative relationships between LWG and both FEC_{28} and FEC_{42} in -ALB FW ewe lambs, and between LWG and FEC_{28} in -ALB FW ram lambs ($P < 0.1$). In each of these three cases the magnitude of the relationship was similar, such that an increase in FEC of 1000 eggs per gram of faeces resulted in a decrease in LWG of approximately 10% (10g/day). No such relationship existed between LWG and FEC in -ALB C lambs.

As with CW, there was no significant change in the superiority of FW lambs over C lambs between -ALB and +ALB treatments. However, trends towards this were evident in both sexes. In ewe lambs FW superiority increased from 9% to 14% between -ALB and +ALB treatment. The increase in superiority was more marked in rams, (9% vs 36% for -ALB and +ALB, respectively).

SUMMARY

It has been shown in this trial that FW lambs have higher FEC's than C lambs, and that lamb FEC's are effectively controlled by albendazole CRC's. The superiority of FW lambs over C lambs in both CW and LWG did not significantly change when FEC's were being controlled by ALB. However, FW lambs produced significantly more wool than C lambs and, FW ram lambs also had greater rates of LWG than C ram lambs. The administration of ALB significantly increased CW in ewes but not ram lambs, and significantly increased LWG in rams but not ewe lambs. No differences in DMI were detected either by flock, or because of the administration of ALB.

CONCLUSIONS

This trial has established trends demonstrating that FW lambs have higher FEC's than C lambs when parasitised in a common environment. From this it appears that there is an undesirable relationship between wool growth and FEC. However, there were no statistically significant results in any of the production traits measured which would suggest that FW lambs exhibit a greater increase in production than C lambs when FEC is controlled by drenching. While trends towards this were observed in some cases, no firm conclusions can be drawn. This is not the result which would be expected if FEC is a reliable indicator of an animal's resistance to internal parasitism. Further knowledge is required about the mechanisms by which internal parasitism produce losses in sheep. If losses are produced not in response to presence of adult worms in the gut (as FEC would suggest), but rather in response to other factors (such as larval ingestion) then breeding for a reduced FEC is unlikely to produce much advantage to sheep farmers, other than a lower rate of pasture contamination with nematode eggs.

Future research must focus on the objective of selection, which is reduced production losses from subclinical internal parasitism. Other criteria to achieve this objective need to be identified and tested. It will be unfortunate if FEC is pursued as a marker of resistance to internal parasitism, at the expense of selection for production traits, if it is only achieving a lower level of pasture contamination with nematode eggs.

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