PRODUCTION COSTS IN SHEEP BRED FOR WORM RESISTANCE DURING HAEMONCHUS CHALLENGE AND INFECTION

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SUMMARY

An *Haemonchus contortus* trickle challenge in sheep had similar effects on production (wool growth and liveweight) in animals selected for worm resistance (IRH) and in unselected controls (CH). In sheep on a good quality diet worm challenge did not affect liveweight change. When fed a poor quality diet unchallenged sheep showed a lower liveweight loss than challenged sheep. Regardless of worm challenge and genotype all sheep grew the same amount of wool. “Mortality” rate (for welfare reasons defined as blood PCV<14%) of CH sheep (25%) was significantly higher than IRH sheep (0%) when under normal worm challenge.

**Keywords:** Merino, breeding for worm resistance, immune response, productivity.

INTRODUCTION

There have been no reports of improved production in sheep selected (within breed) for worm resistance when they are under similar worm challenge to unselected sheep. In fact, in some instances it appears that the productivity of genetically resistant sheep is compromised by selection for worm resistance (Morris *et al.* 2000). Why might this be the case? One hypothesis, that the immune response mounted against worms by resistant sheep carries some cost to the animal (Owens and Wilson 1999), was investigated in an experiment with the CSIRO *Haemonchus* selection lines. There is evidence that sheep exposed to parasite infection suffer production loss from ingesting infective larvae even if these worms do not establish a fully patent infection (Barger and Southcott 1975). Therefore, we also compared the effects on productivity of challenge with sterile larvae versus normal larvae.

MATERIALS AND METHODS

Sheep used in this study were bred in the CSIRO *Haemonchus* selection lines (Woolaston and Piper 1996). Forty ewe weaners (approximately 5 months of age) were selected at random from each of the Increased Resistance to *Haemonchus* (IRH) and the random-bred control (CH) lines. After stratification on liveweight, 10 sheep from each line were allocated at random to 4 larval treatment groups – Low *H. contortus* (1000 L3/wk), High *H. contortus* (2000 L3/wk), Irradiated (sterile) *H. contortus* (2000 L3/wk) or nil worms for the control group. The experiment, initially conducted in individual pens at the University of New England’s animal house, started on 19/02/97. From week 7 *H. contortus* were administered as a thrice weekly trickle challenge. At Week 14 of the experiment it was apparent that the high quality lucerne-based diet was allowing the sheep to compensate for any detrimental effects of the worm challenge. Consequently, for the remainder of the experiment the diet was changed to a lower quality ration of oaten chaff and the high dose of *H. contortus* increased to 4000 L3/week. The experiment ran for 34 weeks, divided into 4 periods based on diet and location:

**Period 1**  Week 1–7, sheep fed *ad libitum* lucerne pellets and nil worm infection
Period 2  Week 7–14, sheep fed *ad libitum* lucerne pellets and trickle infection commenced

Period 3  Week 14–27, diet changed from lucerne to *ad libitum* oaten chaff and high *H. contortus* treatment increased to 4000 L3/week

Period 4  Week 27–34, sheep fed *ad libitum* oaten chaff, moved to group pens at Chiswick, CSIRO, and trickle challenge continued as for Period 3.

The animals were weighed weekly. Greasy wool growth was measured over the 4 Periods using clipped patch technique. Sheep were classified as “dead” when their packed cell volume (PCV) reached 14% or less (for welfare reasons). These sheep were drenched with levamisole and continued in the experiment with no interruption to the challenge. Post “death” production data were included in the analysis. The change in wool growth between the 1st and 2nd, 3rd or 4th Periods was analysed, as was change in liveweight over each Period. Liveweight from Week 1 was omitted and data from Week 14-17 in Period 3 was not included in the analysis as the diet was changed gradually over this time. Analysis of variance was used to test for main effects and interactions. Differences in “deaths” were compared using Fisher’s exact probabilities.

RESULTS AND DISCUSSION

Line had no significant effect on greasy wool growth during any Period, including Period 1, when wool growth was 1.11 and 1.07 g/cm²/d for IRH and CH, respectively. Larval treatment group had no effect on change in wool growth; all sheep responding in the same manner to change in time and diet (Figure 1). There was no interaction between line and larval treatment group for wool growth.

![Figure 1. Change in greasy wool growth (g/cm²/d) between the Period 1 when sheep were not infected and the Periods 2, 3 and 4 when trickle challenge of *H. contortus* was given.](image)

At the outset of the challenge (Period 2) there was no difference between lines for liveweight (25.9 and 25.8kg for IRH and CH, respectively, at Week 7). There were significant differences between experimental groups in liveweight change during Period 1 (Figure 2) but, as treatments had not commenced, these differences can be assumed to be random. Larval treatment group did not significantly affect liveweight change in Period 2 (when the sheep were fed lucerne pellets) but did have a significant effect during Periods 3 and 4 (when the sheep were fed oaten chaff). In Period 3 the
unchallenged group lost less weight than the sheep receiving irradiated larvae or a high dose of normal *H. contortus*, but not the low dose *H. contortus*. In Period 4, both the control and irradiated larval treatment groups lost less weight than the groups receiving either the low or high *H. contortus* infection (Figure 2).

Figure 2. Liveweight change during Period 1 when sheep were not infected and during Period 2, 3 and 4 when trickle challenge of *H. contortus* was given.

Overall, line differences in liveweight change were small (Figure 3). The only significant difference between lines occurred in Period 3, when IRH sheep lost less weight. This difference disappeared in the last experimental phase, and when liveweight change is averaged over these two periods there was little difference between the lines. The only interaction between selection line and larval treatment group was in Period 2, where liveweight gain in IRH sheep was greater than for CH sheep in the irradiated worm treatment, but less in the high *H. contortus* treatment. No sheep died during the experiment. However, sheep were classified as “dead” if their PCV fell to 14% or lower. There were significantly (P=0.024) higher “mortalities” in the CH line: 4 in low *H. contortus* and 1 in high *H. contortus* treatments, resulting in a “loss” of 25% of sheep under normal (not irradiated) worm challenge. There were no “mortalities” in the IRH line. “Mortalities” occurred in Periods 3 and 4, after the change in diet.

The *H. contortus* trickle challenge had similar effects on production in IRH and CH animals. Wool growth was the same for both lines of sheep. Where a liveweight advantage appeared for IRH sheep, it was balanced by a similar advantage for CH sheep in another treatment (as with the interaction in Period 2) or subsequently disappeared over the course of the infection. These results suggest that the productivity of sheep selected for resistance to *H. contortus* may not be different from the productivity of unselected sheep, irrespective of challenge, with the very important exception of potential deaths from haemonchosis. Large differences in faecal egg count and worm numbers were observed in this experiment, favouring the IRH line, (Eady unpublished) which supported differences
between lines in “mortalities”. It is less clear whether resistance in the face of challenge from other worm genera will give similar results.

![Figure 3. Liveweight change for IRH and CH sheep when unchallenged (Period 1) and during trickle challenge with *H. contortus* (Periods 2, 3 and 4).](image)

The irradiated larval treatment was introduced in an attempt to partition the various “costs” of infection between immune response to larval challenge and the detrimental impact of worm infection on the nutrient balance of the animals. There is some suggestion in this experiment that there may be a liveweight cost from larval challenge under poor dietary conditions early (Week 18-27) in the infection, although this cost disappears later, perhaps as a result of well established immunity.

So is there a production cost of being worm resistant? These results indicate little production benefit (excluding probable effects on mortality). One could then argue that there must be a cost because the expectation is that resistant sheep should suffer smaller losses in production because they carry far fewer worms. Perhaps the benefit of fewer worms is matched by the cost of mounting a strong immune response. The message to sheep breeders, from these results, is that selecting for worm resistance may not necessarily lead to more productive sheep, but should produce sheep that can survive and keep worm burdens at a level where their productivity is not compromised.

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**REFERENCES**