GENOTYPE X ENVIRONMENT INTERACTIONS FOR LAMB TRAITS OF MERINO SHEEP

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SUMMARY

Lines of Australian Merino sheep previously selected for high and low weaning weight and a randomly selected control line were compared for a five-year period in two locations in Trangie and Armidale. The Weight Plus lambs were heavier at birth and at weaning and grew faster to weaning than the Weight Minus and Random lambs. Random lambs were superior to the selection lines for birthcoat score and in all traits to the Weight Minus lambs. Lambs raised at Trangie were superior to the lambs raised in Armidale while year effects showed significant influence for all traits. Significant line x location interactions were evident for birth weight, growth rate and weaning weight but involved no rank changes. Location x year interactions were large and highly significant for birth weight, birthcoat score, growth rate and weaning weight while line x year interactions were significant only for birth weight and birthcoat score. The second order interactions of line x location x year were significant for birth and weaning weight and growth rate.

Keywords: Sheep, selection, weaning weight, genotype x environment interaction, lamb traits

INTRODUCTION

Genetic x environmental interactions have important implications to the design and efficiency of a selection program. The interactions resulting from changes in magnitude may be of low significance. However, genetic x environmental interactions that alter the phenotypic ranking of a series of genotypes between environments will considerately hamper the selection program. This will result in a reduction in accuracy of phenotypic ranking of a series of genotypes in one environment. The presence of a substantial interaction means that the selection should be carried out in the environment in which the animals will be kept provided that the environment is fairly predictable. If environmental variation is likely to be unpredictable in time or degree, then the breeder has little choice but to aim at general adaptability over a range of conditions.

In sheep, a number of researchers have focused their work on genetic x environment interactions on traits of economic importance: growth, wool, production, reproduction and carcass traits. Dunlop (1962) reported significant and real interactions for many traits but these were generally small in size, accounting for only a minor fraction of the variance. Lasslo *et al* (1985) worked on genetic x environment interactions of sheep selected for weaning weights and concluded that selection under better feed conditions resulted in greater improvement in growth rate in drylot conditions as did selection under range environment.

This study examined if genotype and environmental interactions existed in two lines of Merino sheep selected for weaning weight and a randomly selected control group. It also determined if the interactions resulted in a change in rank or magnitude of the differences between the three lines when exposed to different environments. Traits studied include birth weight, birthcoat score, lamb survival to weaning, weaning weight and growth rate to weaning.

MATERIALS AND METHODS

The study used animals from the Trangie Weight Selection Experiment conducted by NSW Agriculture between 1951 and 1994 and the AMRC cooperative research project of the NSW Agriculture and the University of New England conducted between 1983 and 1987. The experiment involved two lines of medium-Peppin Merinos selected for high live weight at weaning (Weight Plus) and low weaning weight at weaning (Weight Minus) and a randomly selected control line (Random). Davis (1987a) has described in detail the selection criterion used in each of the selection lines between 1951 and 1983. Between 1983 and 1994, selection was suspended with replacement rams and ewes chosen at random within each line. The selection lines were dispersed in 1995. In this study, data used were on animals born between 1983 and 1987 in the two locations: Trangie and Armidale. Armidale is located on the tableland areas of northern NSW at an elevation of 1,090 m and with an average rainfall of 63.18 mm. for the five-year period. Trangie is on the central western plains of NSW at an elevation of 219 m and with an average rainfall of 39.9 mm.

The Armidale flock was established in the later part of 1982 with the transfer from Trangie of half of the breeding ewes from each of the selection lines and 100 random ewes. Additional animals were transported for each line in 1983. All joinings from 1983 to 1987 were conducted using rams selected randomly from each line from Trangie bred rams. Five to 10 rams per line were used each year and these rams were used in Trangie for joining in February to March and transported to Armidale for an April joining. From Trangie, records were available from 1,519 sheep; 444 in Weight Plus (W+) line, 209 in Weight Minus (W-) line, and 866 in the Random line (R). From Armidale, 929 sheep records were available: 354 in Weight Plus line, 163 in Weight Minus line and 391 in the Random line. During the period of the study, lambs in Trangie were born during July to August and weaned in November to December while Armidale lambs were born and weaned in August to September and December to January, respectively.

Least square analyses of variance were used to estimate the effects of environmental sources of variation on the data for lamb traits. The general linear model procedure (GLM) of the Statistical Analysis System (1990) was used for all analyses. The linear model fitted included fixed effects of selection line, year, location and line x year, line x location, location x year and line x year x location interactions. Sire nested within line x year x location was fitted as a random effect. Day of birth of lamb was fitted as a covariate for birth weight, birthcoat score and lamb survival and lamb age at weaning was fitted as a covariate for weaning weight and growth rate to weaning. Covariates were fitted within cohorts since they showed non-significant effects when fitted within locations.

RESULTS AND DISCUSSION

Genotype effects. The lines selected for high and low weaning weights showed significant differences (P<0.001) for the various lamb traits. The Weight Plus lambs were heavier at birth (13.3 %) and at weaning (12.7 %), grew faster to weaning (13.3 %) and had lower birthcoat scores than Random lambs. In turn, Random lambs performed better than Weight Minus lambs in these traits. The results showed that the responses in the lamb traits observed in the weaning weight selection lines by Pattie (1965) and Davis (1987a, 1987b) were maintained following the suspension of selection. Apparently, the suspension of selection within the weaning weight selection lines did not greatly alter the performance of the animals in the subsequent two generations.

Location effects. Lambs raised at Trangie were heavier at birth by 14.1 %, grew faster to weaning by 5.6 % and were heavier at weaning by 7.3 % than lambs raised in Armidale.

Table 1. Least square means and standard errors of lamb traits as affected by genotype x location interaction

Location	Line	Lamb traits				
		Birth weight (kg)	Birthcoat score	Lamb survival rate	Weaning weight (kg)	Growth rate (g/day)
Trangie	R	3.91 ± 0.04^{b}	3.63 ± 0.08	0.80 ± 0.03	20.05 ± 0.21^{bc}	140.70 ± 1.68^{b}
	W+	4.43 ± 0.04^{a}	2.74 ± 0.09	0.82 ± 0.03	23.88 ± 0.28^{a}	167.91 ± 2.25^{a}
	W-	3.30 ± 0.06^{c}	3.05 ± 0.14	0.73 ± 0.04	15.42 ± 0.44^{d}	108.48 ± 3.59^{c}
Armidale	R	3.43 ± 0.06^{c}	3.11 ± 0.14	0.73 ± 0.04	19.49 ± 0.34^{c}	136.61 ± 2.76^{b}
	W+	3.77 ± 0.06^{b}	2.25 ± 0.14	0.66 ± 0.04	20.61 ± 0.37^{b}	146.31 ± 3.02^{b}
	W-	3.01 ± 0.08^{d}	2.69 ± 0.17	0.66 ± 0.05	16.20 ± 0.52^{d}	105.71 ± 4.23^{c}

*Means between lines having the same superscript did not differ significantly at P<0.05.

Genotype x location interaction effects. Table 1 shows the means for significant genotype x location interactions for birth weight, weaning weight and growth rate and the non-significant interactions for lamb survival and birthcoat scores. In Trangie, Weight Plus lambs were heavier at birth (13.3 %) and at weaning (19.1 %) and grew faster to weaning (19.3 %) than the Random lambs. Compared to the Weight Minus lambs, they were heavier at birth and at weaning and had higher growth rates by 34.2 %, 54.9 % and 54.8 %, respectively. The same result was observed in Armidale although differences between lines were much smaller than in Trangie. In Trangie, differences between the Weight Plus and Weight Minus were 25.2 %, 27.2 % and 38.4 % for birth weight, weaning weight and growth rate, respectively. Interactions in the traits were observed to be generally moderate to small in size and involved no rank changes. The findings showed that location has an effect on the relative performance of the lines, but not on the rankings. This suggest that differences between genotypes will vary depending on the environmental conditions under which the animals are raised.

Other interactions. Lines x year interactions were significant for birth weight and birthcoat scores, but non-significant for lamb survival, weaning weight and growth rate. Both significant interactions involved no changes in rank among lines. Location x year interactions were large and highly significant for most traits. All interactions involved rank changes in location and year, which

indicated the presence of large yearly differences in environmental factors at the two locations. The second order interactions of line x location x year were significant for lamb survival, birthcoat scores and growth rate

ACKNOWLEDGMENTS

The authors wish to thank the staff at Trangie Agricultural Research Centre, particularly Dr. Peter Parnell for his supervision and work and Ms. Anne Burns for data management, and the Australian Meat Research Committee through UNE Project 18S for funding.

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