GENETIC EFFECTS FOR BEEF CATTLE PREWEANING TRAITS

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SUMMARY

Breed direct and maternal additive and heterotic genetic effects were estimated for birth weight, average daily gain and weaning weight from crosses among Angus, Brahman, Charolais and Hereford breeds. Superior growth was shown by the Charolais and inferior maternal ability was demonstrated by the Hereford. The Brahman maternal effect depressed birth weight. Heterosis effects from Brahman combinations increased birth weight and growth to weaning over other breed combinations.

INTRODUCTION

Crossbreeding in the U.S. commercial beef cattle industry has been accepted largely because of the dual advantage of hybrid vigor and complementarity and their associated economic benefits. Knowledge of the relative importance of breed direct and maternal additive and heterotic genetic effects on traits of economic importance is useful when formulating breeding plans. Dickerson (1973) presented a model partitioning genetic parameters for breed utilization. Koger *et al*. (1975), Dillard *et al*. (1980), and Wyatt and Franke (1986) used regression models to partition breed direct and maternal additive and heterotic genetic effects for beef cattle preweaning traits. The objective of this study was to estimate breed direct and maternal additive and heterotic genetic effects for birth weight, preweaning average daily gain and weaning weight from beef cattle crossbreeding data.

MATERIALS AND METHODS

Birth and weaning data were collected on 3,454 calves from four generations of a long term rotational crossbreeding study conducted at the Central Research Station of the Louisiana Agricultural Experiment Station in Baton Rouge, LA. The station is located at latitude 30°31'N and longitude 90°8'W and is 10.6 m above sea level. The environment is subtropical with average maximum and minimum daily temperatures of 26 and 13 degrees C, average maximum and minimum daily humidity of 88 and 54 % and an average annual rainfall of 147 cm.

Angus (A), Brahman (B), Charolais (C) and Hereford (H) breeds were used to form three two-breed (A-B, C-B, H-B), three three-breed (A-B-C, A-B-H, B-C-H) and one four-breed (A-B-C-B) rotation combination. Rotational combinations were initiated with Brahman F-1 cows mated to produce backcross or three-breed cross calves.

All calves were born between January 15 and April 10. Birth weight (**BWT**) was recorded within 24 hr after birth. Weaning weights were taken at an average age of 220 d in early October. Average daily gain (**ADG**) was obtained by subtracting **BWT** from weaning weight and dividing by weaning age. Weaning weight was adjusted to 205 d (**A205WT**) by multiplying **ADG** by 205 and adding **BWT**.

Expected breed composition and breed heterozygosity of calves varied each generation within and across rotation systems and were used as a basis to estimate breed direct and maternal additive and heterotic genetic effects for each trait.

Genetic effects were estimated using a regression model to partition the direct and maternal additive genetic effects associated with breed composition and the direct and maternal heterotic genetic effects associated with breed heterozygosity. A similar procedure was used by Koger et al. (1975), Dillard et al. (1980), and Wyatt and Franke (1986). We deviated direct (Ig) and maternal (Mg) additive genetic effects from the mean, rather than from a particular breed as in the previous papers, so they will sum to zero. Direct and maternal heterosis effects (Ih and Mh) were expressed as deviations from zero. Assumptions made in estimation of genetic effects include: the proportion of genes contributed by each crossbred to a gamete is proportional to the expected breed composition of the crossbred, there is a linear association between the degree of breed heterozygosity and hybrid vigor, and the effects of linkage and epistasis were considered negligible.

RESULTS

Breed direct and maternal additive (Ig and Mg) and heterotic (Ih and Mh) genetic effects for **BWT, ADG** and **A205WT** and selected contrasts are given in Table 1. Charolais Ig effects were positive (P<.01) for all traits whereas B Ig effects were negative (P<.01). Angus and H Ig effects were intermediate and generally not significant. Contrasts indicated C had larger Ig effects for **BWT, ADG** and **A205WT** than the average of A and H Ig effects, and H had larger Ig effects for all traits than A.

The Brahman Mg effect on **BWT** was large and negative but B Mg effects on **ADG** and **A205WT** were positive. Hereford Mg effects were large (P<.01) and negative for **ADG** and **A205WT**. The B Mg effect on **BWT** was smaller than the average of A, C, and H Mg effects, but B Mg effects on **ADG** and **A205WT** were larger than the average A, C and H Mg effects. For **ADG** and **A205WT**, the C Mg effect was greater than the average A and H Mg effects, and the A Mg effects for **ADG** and **A205WT** were greater than those of H.

Most Ih effects significantly influenced expression of **BWT, ADG** and **A205WT**. Angus-Brahman, B-C and B-H Ih effects on **BWT, ADG** and **A205WT** were large (P<.01) and greater than the average Ih effects of non-Brahman combinations. Angus-Brahman Ih effects were larger for all three traits than the B-H Ih effects. Angus-Charolais Ih effects for **ADG** and **A205WT** were larger than Ih effects from C-H.

All B combination Mh effects on **BWT** were negative (P<.01) and smaller than the average of non-Brahman Mh effects. Brahman combination Mh effects for **ADG** and **A205WT** were significantly larger than those from non-Brahman combinations. Brahman-Hereford Mh effects for **ADG** and **A205WT** were larger than A-B Mh effects. **ADG** and **A205WT** Mh effects from C-H were larger (P<.01) than those from A-C.

DISCUSSION

The genetic effects reported here help explain phenotypic variation observed in birth and preweaning traits among rotation systems and breed combinations. Direct additive and Mg effect differences were closely associated with mean differences among purebreds. Differences among breed Ig and Mg effects found in this study were in the same direction as those reported by Wyatt and Franke (1986), but tend to be smaller. It is clear in these data that the B Mg effect suppresses **BWT** and the H Mg effect influences inferior maternal ability. The superior C Ig effect for growth was demonstrated.

Angus-Brahman, B-C and B-H Ih genetic effects help explain large birth weights of Brahman F-1 calves from _Bos taurus_ females. Brahman combination Ih effects on **ADG** and **A205WT** were larger than from non-B combinations, supporting previous crossbreeding research with the Brahman. Larger Ih genetic effects for **ADG** and **A205WT** from A-C were shown in these data than were shown for A-C by Wyatt and Franke (1986) and Olson _et al_. (1993). Differences among Mh genetic effects found in these data are in the same direction as those found by Wyatt and Franke (1986) and by Olson _et al_. (1993), but their effects were positive whereas most of the effects found in this study were negative.

LITERATURE CITED

DICKERSON, G.E. (1973) In Proc. Anim. Breed. Symp. in Honor of Dr. J.L. Lush. pp 54-77. Am. Soc. Anim Sci., Champaign, Il.

DILLARD, E.U., RODRIGUEZ, O. and ROBISON, O.W. (1980) J. Anim. Sci. 50:653-663.

KOGER, M., PEACOCK, F.M., KIRK, W.G. and CROCKETT, J.R. (1975) J. Anim. Sci. 40:826-833.

OLSON, T.A., PEACOCK, F.M. and KOGER, M. (1993) J. Anim. Sci. 71:2322-23329.

WYATT, W.E. and FRANKE, D.E. (1986) Southern Region Bull. #310. LAES, Baton Rouge, LA.

Table 1. Genetic effects and selected contrasts

Genetic effects	BWT	ADG	A205WT
Direct additive, Ig_i			
A	-4.4**	-.034**	-11.4**
B	.2	-.026*	-5.1
C	5.5**	.055**	16.8**
H	-1.4**	.005	-.4
(A+C+H)/3 - B	-.3	.034*	6.7
(A+H)/2 - C	-8.4**	-.069**	-22.6**
A - H	-2.9**	-.039	-11.1**
Maternal additive, Mg_i			
A	1.6**	-.014	-1.3
B	-3.8**	.057**	7.8**
C	1.2*	.057**	12.9**
H	1.0	-.099**	-19.5**
(A+C+H)/3 - B	5.1**	-.076**	-10.5**
(A+H)/2 - C	.1	-.114**	-23.3**
A - H	.7	.086**	18.2**
Direct heterotic, Ih_{ij}			
AB	8.6**	.263**	62.5**
AC	-.5	.193**	39.1**
AH	2.6**	.095**	22.1**
BC	7.6**	.194**	47.5**
BH	6.8**	.169**	41.5**
CH	1.0	.094**	20.4**
(AB+BC+BH)/3 - (AC+AH+CH)/3	6.7**	.081**	23.3**
(AB+BH)/2 - CB	.1	.022	4.6
AB - BH	1.8**	.094**	21.0**
(AC+CH)/2 - AH	-2.4**	.049*	7.6
AC - CH	-1.6	.099**	18.7**
Maternal heterotic, Mh_{ij}			
AB	-3.6**	-.052**	-14.2**
AC	-1.7	-.164**	-35.4**
AH	-.9	-.051**	-11.3*
BC	-4.5**	-.019**	-8.4
BH	-2.8**	.028**	3.0
CH	.0	-.033**	-6.8
(AB+BC+BH)/3 - (AC+AH+CH)/3	-2.7**	.069**	11.3**
(AB+BH)/2 - BC	1.3*	.007	2.8
AB - BH	-.8	-.080	-17.3**
(AC+CH)/2 - AH	.1	-.048*	-9.8*
AC - CH	-1.8	-.131**	-28.6**

*P<.05; **P<.01