GENETIC ASSOCIATIONS OF GROWTH AND LACTATION CURVE COMPONENTS IN POLLED HEREFORD CATTLE

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Summary

Weight and milk production records of Polled Hereford cows born from 1967 to 1979 were used to fit growth and lactation curves. A multiple-trait, derivative-free, restricted maximum likelihood (MTDFREML) procedure, utilizing a full animal model, was used to estimate variances and covariances for the components of the growth and lactation curves. For the growth curve,

$$W=A+B(1-e^{-kt})$$

components A, B, and k each had moderate to high heritabilities ranging from .35 to .72. The genetic correlation between growth curve components A and B was positive (.42), whereas the genetic correlations between A and K (-.34) and between B and K (-.74) were negative. In the lactation curve,

$$Yn=n/(ae^{km})$$

heritabilities of components k and a were .15 and .40, respectively. The genetic correlation between these lactation curve components was -.78.

(Key Words: Growth Curve, Lactation Curve, Heritability, Genetic Correlation, Polled Hereford.)

Introduction

Growth improvement is an emphasis of most breeding programs. Mathematical components of growth curves provide a means to evaluate various aspects of animal growth. Milk production has a major influence on calf weaning weights. The ability to predict milk production can be useful in improving calf weaning weight and matching cows to various environments. Total milk production per lactation can be predicted by inputting daily milk records into lactation curves. The purpose of this study was to estimate the heritabilities and genetic correlations of growth curve and lactation curve components.

Experimental Procedures

Beginning in 1967, a study was initiated to examine the effects of selection for improved feed conversion. At the start of the 1971 breeding season, cows were assigned randomly to either the selection or control herd. Lifetime records (monthly weights and heights) were recorded on females born in both herds. Cows that attained the age of 10 years while in the herds and had complete monthly weight and height records from ages 5 to 10 were used to estimate mature weight and mature height. Average weight and average height over the 5-year period were considered to be mature weight and mature height. Monthly cow weights were used to fit a growth curve. The three parameter function,

$$W_t = A + B(1 - e^{-kt}),$$

where W_t = weight at time t, A = weight at time zero, B = gain from time zero to infinity, e = base of natural logarithms, k = function of the rate of growth, and t = time, pro-

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vided a means to describe the growth and development of the cattle in this study.

During the final 3 years of the study, 205-day milk production was measured on a number of the cows. Twenty-four hour milk yields were estimated once each month, from April through August, using the weigh-suckle-weigh technique. This provided measures of milk production for each cow in each year. Data for each cow were used to fit the lactation curve

$$Y_n = n/(ae^{kn}),$$

where $Y_n = 24$ hour milk yield in the nth week of lactation, e = base of natural logarithms, and a and k = parameters that define the shape of the curve.

A multiple-trait, derivative-free, restricted maximum likelihood (MTDFREML) procedure was used to analyze the data generated in this study. A full animal model was used to calculate the genetic and phenotypic (co)variances. Age of cow was the only fixed effect included in the model during the analyses of maximum height and maximum weight. Year of milking and age at milking were the fixed effects used during the analyses of milk production.

Results and Discussion

The heritabilities (h^2) and genetic correlations (r_g) for the growth curve and lactation curve components are presented in Table 1. The heritabilities of the lactation curve components k and a were found to be .15 and .40, respectively. The genetic correlation between these lactation curve components was -.78.

Reported heritabilities of growth curve components are generally moderate to high. In this study, growth curve components A, B, and k had heritabilities of .35, .72, and .46, respectively. These heritabilities suggest that selection for weight, gain, and rate of maturity can be effective. The genetic correlation between growth curve components A and B ($r_g = .42$) was positive, which is similar to reported genetic correlations between birth weight and mature weight. The genetic correlations between growth curve parameters A and k ($r_g = -.34$) and B and k ($r_g = -.74$) were negative. The negative association between B and k suggest that animals maturing fastest weigh less at maturity.

Table 1. **Heritabilities and Genetic Correlations of Growth[a] and Lactation[b] Curve Components[c]**

Traits[d]	GCVA	GCVB	GCVk	MLKk	MLKa
GCVA	**.35**				
GCVB	.42	**.72**			
GCVk	-.34	-.74	**.46**		
MLKk	n/a	n/a	n/a	**.15**	
MLKa	n/a	n/a	n/a	-.78	**.40**

[a]Growth curve: $W_t = A + B(1 - e^{-kt})$, where W_t = weight at time t, A = weight at time zero, B = gain from time zero to infinity, e = base of natural logarithms, k = function of rate of growth, and t = time.
[b]Lactation curve: $Y_n = n/(ae^{kn})$, Y_n = the 24-hour milk yield in the nth week, e = base of natural logarithms, and a and k = parameters that define the shape of the curve.
[c]Heritabilities (bold, underlined) lie on the diagonal; Genetic correlations lie below the diagonal.
[d]GCVA = growth curve component "A"; GCVB = growth curve component "B"; GCVk = growth curve component "k"; MLKk = lactation curve component "k"; MLKa = lactation curve component "a".