Evaluation of Egg Production in Layers Using Random Regression Models

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Summary and Implications

The objectives of this study were to estimate genetic parameters for egg production over the age trajectory in three commercial layer breeding lines, which represent different biotypes for egg production, and to validate the use of breeding values for slope as a measure of persistency to be used in the selection program. Egg production data of over 26,000 layers per line from six consecutive generations were analyzed. Daily records were cumulated into biweekly periods. Data were analyzed with a random regression model with linear polynomials on period for random additive genetic and permanent environmental effects. In all lines, a nonzero genetic variance for mean and slope and a positive genetic correlation between mean and slope were estimated. Breeding values for slope well reflected the shape of the egg production curve and can be used to select for persistency of egg production. The model proposed in this study appealing for implementation in large and multiple populations under commercial conditions by breeding companies or other breeding organizations.

Introduction

The rate of egg production is the most important trait in layers as it ultimately determines the number of eggs produced in a given period of time. One of the main concerns for the poultry breeder is how to best define egg production as a trait for selection. The rate of egg production changes over time, and can be represented in terms of a "production curve". The shape of the curve is defined by the following stages: (a) sexual maturity (which marks the onset of production), followed by a stage of increasing production to a maximum or (b) production peak, followed by a steady decline in egg production or (c) persistency of production. In modern layers, the production rate almost reaches its maximal biological potential (i.e., one egg per hen per day) during peak production; therefore there is hardly any variation among birds at this stage. What differs among birds is how long they can maintain a high rate of lay and at what rate production decreases after the peak. Statistical models, called random regression models can be used to describe changes of breeding values over time. For birds with desired high persistency, their advantage over contemporaries increases with age. Therefore, they are expected to show positive breeding values for slope past peak production when breeding values are expressed as deviations from the average egg production curve. The objectives of this study were to estimate genetic parameters for egg production over the age trajectory in three commercial layer breeding lines, which represent different biotypes for egg production, and to validate the use of breeding values for slope as a measure of persistency to be used in the selection program

Materials and Methods

Egg production data over six generations from three purebred layer lines, representing different biotypes for egg production, were made available by Hy-Line International. Two of the lines produced white eggs but of differing egg size: a small white-egg line (SWE) and large white-egg line (LWE); while the third line was a brown-egg layer (BE). The data were recorded daily from the first egg to 47 weeks of lay and cumulated into number of eggs produced per biweekly periods. A total of 26,719; 31,531 and 31,059 hens were recorded, resulting in 307,462; 379,786 and 372,288 biweekly records included for the SWE, LWE and BE lines, respectively. Data were analyzed with a random regression model with a 5^{th} order polynomial on period within hatch as fixed effect and random linear regressions for genetic and permanent environmental terms. A separate residual variance was fitted for each biweekly period. The variance components and parameters were estimated using the ASREML program.

Results and Discussion

In all lines, a nonzero genetic variance for slope and a positive genetic correlation between mean and slope was estimated. Genetic variance of egg production was low at the beginning of lay and increased as the birds aged for all three lines, which resulted in heritability estimates increasing with age. Differences in estimated breeding values (EBV) for slope reflected differences in persistency of egg production between birds well, i.e. birds with a positive EBV for slope remained high along the trajectory; whereas egg production dropped substantially for those with a negative EBV for slope. Fitting a linear order polynomial for the additive genetic term herein allowed for relatively quick convergence and resulted in prediction of breeding values, which can be directly used to select for persistency of egg production.