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Manjeet
Department of Animal Genetic and Breeding, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

DS Dalal
Department of Animal Genetic and Breeding, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Vikram Jakhar
Department of Animal Genetic and Breeding, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Ramkaran
Department of Veterinary Physiology and Biochemistry, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

CS Patil
Department of Animal Genetic and Breeding, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Sunil Sharma
Department of Animal Genetic and Breeding, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Correspondence
DS Dalal
Department of Animal Genetic and Breeding, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar, Haryana, India

Prediction of 40 week egg production on the basis of performance and cumulative part egg production in synthetic white leghorn strain

Manjeet, DS Dalal, Vikram Jakhar, Ramkaran, CS Patil and Sunil Sharma

Abstract
A study of white leghorn strain maintained at the poultry farm of department of Animal Genetics and Breeding, LUVAS, Hisar, was conducted to investigate the possibility of prediction of the 40 week egg production based on performance and cumulative part egg production traits. The performance traits studied were body week at 20 week of age (BW_{20}) and age at first egg (AFE) and cumulative part egg production traits were egg production upto 24 weeks of age (EP_{24}), egg production upto 28 weeks of age (EP_{28}), egg production upto 32 weeks of age (EP_{32}), egg production upto 36 weeks of age (EP_{36}) and egg production upto 40 weeks of age (EP_{40}). Multiple regressions analysis was used to predict the 40 week egg production from performance and cumulative part egg production traits. Prediction equation for 40 weeks egg production showed highest coefficient of determination (90%), when only EP_{36} was entered in the prediction equation.

Keywords: White leghorn, performance traits and prediction equation

Introduction
Poultry is one of the fastest growing segments of agricultural sector in India with an average growth rate of 4.94%. The total egg production in India is about 88139 millions and the per capita availability of 69 eggs per year (BAHS, 2016-17) against ICMR recommendation of 180 eggs per year. The rate of egg production is the most important trait in layers because it ultimately determines the number of eggs produced in a given period of time. The synthetic strain of white leghorn has undergone long-term selection for many generations on the basis of 40-week part-period egg production and is being maintained at this institute for development of egg type strain.

It has now become a common practice among the breeders to practice selection based on part term egg production for improving the egg production at later stages. The length of the part record that is likely to produce greatest improvement in egg production at later stages can also be identified. This attempt may further be expected to improve the annual egg production as well as the number of chicks per breeder dam for higher economic efficiency of production per unit time. Egg production is a genetically controlled trait with a behavioural pattern specific to a breed or a line. It can also be expressed as a function of duration from which the bird is in production. Egg production generally increases to a peak and then gradually decreases in the form of a curve when summarized on a monthly or weekly basis (Abraham, 2006) [1]. Prediction? So, the present study was conducted with the objective to predict 40 week egg production on the basis of performance and cumulative part egg production in synthetic White Leghorn strain.

Material and methods
The relevant data for the present investigation were collected from synthetic White Leghorn population, maintained at the poultry farm of department of Animal Genetics and Breeding, LUVAS, Hisar. The data were collected over five generations (2012-13 to 2016-17). The birds have been maintained under uniform practices of feeding, housing and management during the period of data recording as far as possible. The following traits were taken for study i.e. Body weight at 20 week of age (BW_{20}), age at first egg (AFE), egg production upto 24 weeks of age (EP_{24}), egg production upto 28 weeks of age (EP_{28}), egg production upto 32 weeks of age (EP_{32}), egg production upto 36 weeks of age (EP_{36}) and egg production upto 40 weeks of age (EP_{40}).

Multiple Regression Analysis (MRA) as described by Draper and Smith (1987) [3] were used to predict breeding values of 40 weeks egg production from cumulative part egg production and other performance traits.
Prediction equation was as follow:

$$\hat{Y} = a + b_1X_1 + b_2X_2 + \ldots\ldots\ldots b_pX_p$$

Where,
$\hat{Y}$=a variable which is to be predicted (dependent)
â= a constant (intercept)
b_i = partial regression of Y on i^{th} X traits
X_i = independent variables
The coefficient of determination was calculated on the basis of following formula:

$$R^2 = \frac{\text{Regression sum of squares}}{\text{Total sum of squares}} \times 100$$

Results and discussion
Total 19 equations were developed for predicting 40 weeks egg production based on performance and cumulative part egg production traits and are presented in Table 1.The developed equations were in different combination of one, two or three performance traits or/and part cumulative egg production traits. Performance traits taken were BW_{20} and AFE, and part cumulative egg production traits taken for predicting 40 weeks egg production were $EP_{24,}$ EP_{28}, EP_{32} and EP_{36}. Prediction equation for 40 weeks egg production showed highest coefficient of determination (90%), when only EP_{36} was entered in the prediction equation. When egg production at 36 weeks of age was taken in prediction equation with combination of either BW_{20} or AFE or with both BW_{20} and AFE then also R^2 value was 90%. When other traits without EP_{36} were entered in the equation, the R^2 value remained up to 75-76%. These results indicated that EP_{36} alone explained 90% of variation in $EP_{40.}$

Table 1: Prediction of 40 weeks egg production on the basis of performance and part cumulative egg production

S. No	Predicted equations	R^2 (%)
1.	$\hat{Y}$ = 86.78 - 0.003 BW_{20}	20
2.	$\hat{Y}$ = 103.32-0.134 AFE	17
3.	$\hat{Y}$ = 60.62 + 2.81 EP_{24}	33
4.	$\hat{Y}$ = 34.64 + 1.91 EP_{28}	60
5.	$\hat{Y}$ = 10.00 + 1.58 EP_{32}	75
6.	$\hat{Y}$ = 2.23 + 1.23 EP_{36}	90
7.	$\hat{Y}$ =112.29-0.05 BW_{20} +-0.15 AFE	21
8.	$\hat{Y}$ = 68.55 -0.01 BW_{20} + 2.85 EP_{24}	34
9.	$\hat{Y}$ = 42.60 -0.01 BW_{20} + 1.90EP_{28}	61
10.	$\hat{Y}$ =13.49 -0.03 BW_{20} + 1.58EP_{32}	76
11.	$\hat{Y}$ = 3.49 -0.01 BW_{20} + 1.23EP_{36}	90
12.	$\hat{Y}$ = 62.77 -0.14 AFE + 2.80EP_{24}	33
13.	$\hat{Y}$ = 36.18 -0.10 AFE + 1.91EP_{28}	60
14.	$\hat{Y}$ = 11.27 -0.08 AFE + 1.58EP_{32}	75
15.	$\hat{Y}$ = 3.57 -0.18 AFE + 1.23EP_{36}	90
16.	$\hat{Y}$ = 74.24 -0.06 BW_{20} + -0.03 AFE + 2.81EP_{24}	34
17.	$\hat{Y}$ = 47.73 -0.06 BW $_{20}$ + -0.29 AFE + 1.90EP_{28}	61
18.	$\hat{Y}$ = 16.48 -0.03 BW_{20} + -0.02 AFE + 1.58EP_{32}	75
19.	$\hat{Y}$ = 5.62 -0.01 BW_{20} + -0.01AFE + 1.23EP_{36}	90

The R^2 in present investigation were in conformity with findings of Kumar *et al*., (1997) [4] who formed prediction equation for annual egg production up to 64 wk of age based on EN_{40}, EN_{44}, EN_{48}, EN_{52}, body weight at 16 wk of age and AFE in various combinations. The R^2 values for such equations increased from 53.3 percent to 87.1 percent, with increase in the length of recording egg numbers. Similarly, Devi (2002) [6] observed the values of the coefficient of determination, R^2 for the regression equations predicting EP_{64} from the combination of respective part records and AFE were as 35.03, 49.27, 55.19, 62.48 and 77.96 percent, respectively. Abraham (2006) [1] adopted step wise regression analysis and developed prediction equation to estimate part term egg production up to 40 and 52 week of age from various segments of egg production, age and body weight at sexual maturity. The prediction equations recommended were: EP_{40} = 7.1450 + 1.387 (P1) + 0.966 (P2) + 1.444 (P3); EP_{40} = 16.917 + 1.035 (EP_{36}); EP_{52} = 11.904 + 1.414 (P1) + 1.308 (P2) + 1.420 (P3) + 1.823 (P4) and EP_{52} = 35.081 + 1.149 (EP_{40}). The R^2 values of these equations were 82.5 percent, 92.9 percent, 70.2 percent and 79.4 percent, respectively.
Samari *et al*., (2008) [7] also formulated simple and multiple regression equation for predicting total egg production from partial or cumulative egg production in a stock of white leghorn in Iraq and concluded that the choice of the favourable prediction equations in dealing with partial egg production were that depended on second and third month egg production, whereas first 3 or 4 months could be the best choices in case of cumulative egg production. These findings are in accordance with present investigation.
Kapishwar (2017) [5] also formed the regression equation based on the optimum body weight and age at first egg of the pullets for maximum egg production. He found that the pullets producing more number of eggs should attain a body weight of 1900±50 g at 20 weeks of age.
Results indicated that prediction equation based on EP_{36} alone or in combination with AFE and BW_{20} is the best for prediction of 40 week egg production. Prediction of egg production on the basis of partial or cumulative egg production can be done and may be used as early selection criteria. As a result of selection on the basis of partial or cumulative records, generation interval would decrease and genetic gain measured against time would improve.

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