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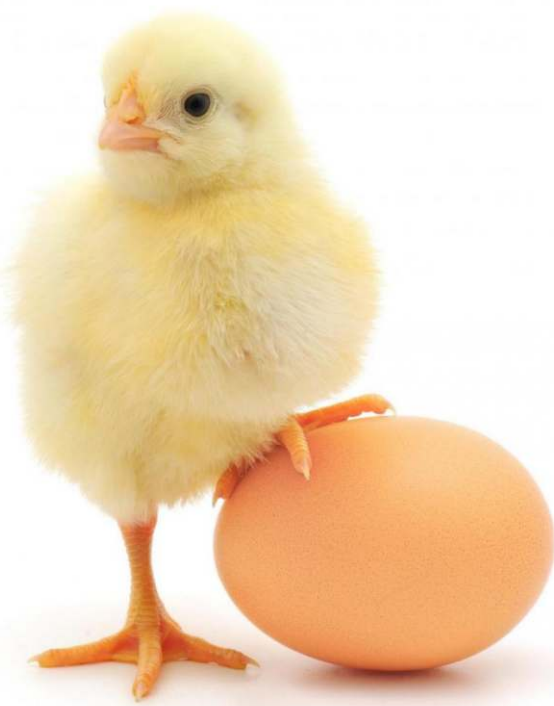

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Prediction of Total Egg Production from Partial or Cumulative Egg Production in a Stock of White Leghorn Hens in Iraq

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Abstract: A study of White Leghorn hens at a poultry farm, Department of Animal Resources, College of Agriculture, University of Baghdad, Iraq, was conducted to investigate the possibility of prediction of the total egg production from partial or cumulative egg production during one year after onset laying. Results revealed that weight at sexual maturity had no significant effect on all studied traits. Simple and multiple regressions were used to estimate prediction equations for the whole egg production from partial and cumulative egg production. It is concluded that the choice of the favorable 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.

Key words: Egg production, cumulative, partial, prediction equation

Introduction

The common objective of commercial breeders of laying stocks is to increase the number of eggs produced per unit of time, because egg production represents the primary trait in laying hens (McMillan *et al*., 1990). The useful method to improve poultry performance is based on two alternative approaches: crossbreeding and selection (Szwaczkowski *et al*., 2003). Thus, the use of partial or cumulative egg records as a selection criterion for improving annual egg production has often been cited as a procedure for obtaining this objective in the shortest possible time (Bohren, 1970). It has been shown (Lerner and Cruden, 1948) that because of high genetic correlation between part of a year production and total annual production, selection for the latter based on the former would not diminish genetic progress as compared to selection based on complete records. The generation interval resulting from selection on part of a record will probably be more than offset the loss in efficiency if records are taken for about half of the full laying year. Hence, genetic gain measured against time would be improved as the parental age is reduced (Dickerson and Hazel, 1944). Thus, the value of using part of the annual egg production at the early selection of superior sire's and dam's lines in chickens has been widely accepted. This was confirmed by the results obtained by Van Vleck and Doolittle (1964). They reported that if cumulative records of not more than five or six months are used in conjunction with a supplemental measure of age at sexual maturity, the relative efficiency of selection on part of records will increase rapidly. However, selection based on part of records has significant unfavorable effects on some important traits, including earlier age at first egg, poorer laying persistency after peak (Yang, 1994) and lower selection accuracy (Luo *et al*., 2007).

Despite the importance of egg production, the reports on relation between partial or cumulative egg productions with the whole egg production in poultry were scanty in Iraq. All researchers in Iraq depend on their assumption on the results conducted in other countries which revealed that part or cumulative egg production can be used as an effective tool in selection for increasing egg production, so it is imperative to investigate the relationship between partial and cumulative egg production with the total egg production in Iraq. Unfortunately with limited resources, the availability of a large data set for such studies is often precluded and a major drawback to using small number of records for analysis is that the application of the standard statistical procedures to these data are unlikely to estimate prediction equation within narrow confidence limits. Farooq *et al*. (2002) demonstrated that reliability of prediction equations could be increased and errors of prediction could be reduced through increasing sample size, Haruna *et al*. (2007) reported that prediction of the whole egg production from part of records can be maximized by a careful analysis of appropriate data. Hence, we will expect that the reliability of the results of this study may not be high with such a small number of records. Anyway this study deserves attempting and still represents an important step that must be followed by other studies to improve poultry productive performance in Iraq.

Materials and Methods

This experiment was conducted at a poultry farm, Department of Animal Resources, College of Agriculture, University of Baghdad, raq, from 15, 10, 2004-30, 9, 2005.

One hundred and thirty one White Leghorn hens at 20 weeks of age represent a randomly bred population that were kept individually in cages with dimensions 40 x 40 x 50 cm and where fed *ad libitum* on compound feed containing 16% crude protein and 2708 kcal/kg ME. Both body weights at onset of laying and egg production were recorded daily during the experimental period in order to estimate prediction equations for the whole egg production depending on partial or cumulative egg production as early selection criteria.

Statistical analysis: General Linear Model (GLM) in SAS program (2001) was used to investigate the effect of weight at sexual maturity on partial and cumulative egg production besides the whole egg production:

$$Y_{ij} = \mu + W_i + e_{ij}$$

Where Y_{ij} is any considered trait in this study, μ is the overall mean, W is the fixed effect of weight at sexual maturity I (I = 1-3) which is 1 = lower than 1200 kg, 2 = 1200-1400, 3 = higher than 1400 kg, e_{ijk} is the residual effect.

Duncan's multiple range tests were used to compare differences among least square means of all studied traits.

Simple and multiple linear Regression were used to estimate prediction equations of the whole egg production from partial and cumulative egg production. Prediction equations were ranked after making a comparison between the prediction equations according to five criteria (Coefficient of determination (R^2), adjusted R^2, Malow value (Cp), Residual mean square (MSE), Residual sum square (SSE).

Results and Discussion

The means of total annual egg production through one year before the onset of laying: first month, second month, third month, forth month, first 2 months, first 3 months and first 4 months were 264.84, 27.46, 28.69, 25.67, 22.16, 56.16, 81.84 and 104.00 eggs, respectively (Table 1, 2).

The present estimation of total egg production is higher than the estimate 192.8 eggs by Amer (1964) for Leghorn hens in Egypt, but this estimate is still lower than standard estimates, which is probably due to the decreasing of persistency and (or) increasing in the occurrence of pauses for hens in tropical areas (Hays, 1924).

Analysis of variance obtained that variation in all traits due to weight at sexual maturity had no significant effect. These findings agree with the results of Nwagu *et al.* (2007), but disagree with the results obtained by Van Vleck and Doolittle (1964).

The partial egg production increased from first to second month and then decreased rapidly in latter months which confirmed the claim of North and Bell (1990) who revealed that a typical egg production curve of a flock increased rapidly during the first 8 or 9 weeks of production and then decreased at a constant rate to the end of the production period. Whereas, Grossman and Koopl (2001) obtained that on an individual hen basis, egg production increased rapidly during the first 2 weeks to a plateau that was maintained for several weeks prior to a gradual decline. Although patterns in egg production are genetically programmed, they may be modified by environmental factors such as nutrition and photoperiod (Pavlidis *et al.*, 2002). The estimates of correlations of first, second, third and fourth month with total production were 0.68, 0.72, 0.71 and 0.68, respectively (Table 3). These estimates were lower than estimates by Oni *et al.* (2007), whereas estimates of correlations between first 60, 90 and 120 days and total egg production were 0.79, 0.82 and 0.83, respectively. This agrees with reports of other worker (Van Vleck and Doolittle, 1964; Anang *et al.*, 2002; Oni *et al.*, 2007).

Table 4 shows some accuracy criteria which were used to rank prediction equations of total egg production from partial egg production. It was obvious that the second month had the best choice according to the values of accuracy criteria. The prediction equations were as follows:

$$\hat{Y} = -112.74+13.15\ (M2)\ \ldots\ldots\ 1$$

When we used multiple regressions for two, three and four months the favorable equations according to their accuracy criteria were as follows:

$$\hat{Y} = -126.74 + 9.33\ (M2) + 4.81\ (M3)\ \ldots\ldots\ 2$$

$$\hat{Y} = -115.22 + 0.46\ (M2) + 0.38\ (M3) + 0.17\ (M4)\ \ldots\ldots\ 3$$

$$\hat{Y} = -119.88 + 1.37\ (M1) + 7.89\ (M2) + 3.19\ (M3) + 1.73\ (M4)\ \ldots\ldots\ 4$$

From all prediction equations it was no doubt that the equation 2 was more acceptable because it could be used in an early period besides the little differences of its accurate criteria compared with equation 4. On the other hand the prediction equations of total egg production from cumulative egg production were as follows:

$$\hat{Y} = -110.87+6.68\ (M1+M2)\ \ldots\ldots\ 5$$

$$\hat{Y} = -69.83+4.08\ (M1+M2+M3)\ \ldots\ldots\ 6$$

$$\hat{Y} = -41.65+2.94\ (M1+M2+M3+M4)\ \ldots\ldots\ 7$$

When we compared the three equations according to their accuracy (Table 5), it was verified that there were

Table 1: Least square means ±S.E for partial egg production in Leghorn hens

Factors	No. of obs.	No. of eggs ± S.E. M1	M2	M3	M4
Overall means	131	27.46±0.18	28.69±0.13	25.67±0.24	22.16±0.23
Lower than 1200 kg	51	27.58±0.29	28.74±0.21	25.58±0.38	21.98±0.38
1200 – 1400	35	27.27±0.36	28.55±0.25	25.58±0.47	21.90±0.46
Higher than 1400kg	45	27.47±0.31	28.74±0.22	25.86±0.41	22.55±0.40

Means in the same column did not differ significantly (P < 0.05) , M1 = First month, M2 = Second month, M3 = Third month, M4 = Forth month.

Table 2: Least square means ±S.E for cumulative egg production and total annual production in Leghorn hens

S.E Factors	No. of obs.	No. of eggs ± S.E. 6o days	90 days	120 days	One year
Overall means	131	56.16± 0.27	81.84± 0.47	104.00± 0.66	264.84± 2.36
Lower than 1200kg	51	56.33± 0.45	81.91± 0.76	103.80± 1.07	262.96± 3.80
1200 – 1400	35	55.82± 0.54	81.44± 0.92	103.31± 1.30	262.35± 4.58
Higher than 1400kg	45	56.22± 0.48	82.08± 0.81	104.64± 1.14	268.66± 4.04

Means in the same column did not differ significantly (P < 0.05)

Table 3: Pearson's correlation coefficients between each of partial and accumulative egg production with whole egg production in Leghorn hens

Trait	Correlation coefficient (r)
First month	0.68**
Second month	0.72**
Third month	0.71**
Fourth month	0.68**
First two months	0.79**
First three months	0.82**
First four months	0.83**

** (P < 0.01)

differences among them. Then, we concluded that equation 6 or 7 would be the best to predict of total egg production due to their high accurate values compared with other equations.

The primary objective of this study is to find prediction equations for the total egg production that depends on partial or cumulative egg production as early selection criteria. The generation interval resulting from selection on partial or cumulative records would be decreased and genetic gain measured against time would be improved, but this is not the only way to maximized egg production because genetic gain could be increased also as heritability and selection deferential increased. Results indicated that prediction equation according to second month and prediction equation that depended on the first 3 months had a proper accuracy and could be used in selection.

There are four determinants of egg production which are important in partial and cumulative egg production records. These determinants are sexual maturity, intensity of production, persistency and occurrence of pauses, so if we aim to get more accurate equations, we must adjust the equations for these factors.

Table 4: Some accuracy criteria used to rank the prediction equations of total egg production from partial egg production in Leghorn hens

In	R^2	Adj. R^2	C (p)	MSE	SSE	Variables
1	0.525	0.522	104.00	350.66	45235.5	M2
1	0.506	0.502	113.60	365.21	47112.7	M3
1	0.475	0.471	128.70	388.26	50085.8	M4
1	0.470	0.466	131.00	391.68	50527.1	M1
2	0.722	0.718	10.17	206.81	26472.8	M2 M3
2	0.661	0.655	40.14	252.68	32343.3	M2 M4
2	0.639	0.633	50.75	268.91	34421.3	M1 M2
2	0.599	0.583	70.11	298.53	38212.2	M1 M4
2	0.578	0.571	80.58	314.54	40262.1	M3 M4
2	0.570	0.563	84.43	320.44	41016.3	M1 M3
3	0.736	0.730	5.28	197.83	25124.5	M2 M3 M4
3	0.727	0.721	9.72	244.67	25993.0	M1 M2 M3
3	0.703	0.696	21.61	233.00	28321.3	M1 M2 M4
3	0.623	0.615	60.19	282.50	35878.4	M1 M3 M4
4	0.741	0.733	5.00	195.84	24676.4	M1 M2 M3 M4

R^2 = Coefficient of determination, Adj. R^2 = Adjusted coefficient of determination, C (p) = Malow value,
MSE = Mean square of residual, SSE = Sum square of residual.

Table 5: Some accuracy criteria used to rank the prediction equations of total egg production from cumulative egg production in Leghorn hens

In	R^2	Adj. R^2	C (p)	MSE	SSE	Variables
1	0.693	0.691	22.08	226.33	29197.6	M1+M2+M3+M4
1	0.679	0.677	29.14	237.05	30579.6	M1+M2+M3
1	0.626	0.623	55.16	276.55	35675.9	M1+M2

R^2 = Coefficient of determination, Adj. R^2 = Adjusted coefficient of determination, C (p) = Malow value,
MSE = Mean square of residual, SSE = Sum square of residual.

Selection is the first step to improve egg production which can be applied according to prediction equations which depend on partial or cumulative egg production. When our investigation is focused in term of more response to selection, in this case, we must estimate genetic parameters of partial and cumulative egg production and then choose an equation according to the highest heritability value and genetic correlation. That means if we try to get more response in selection, it will be necessary to conduct another research to estimate the genetic parameters of these two traits to determine, on the light of their results, which of them is the best in prediction of total egg production.

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