Study on the Increase of Egg Weight and Early Selection based on Part Record in Layer

Y. H. Choi and B. K. Ohh
College of Agriculture, Seoul National University

産卵種鷄의 卵重 增大性과 早期選拔에 關한 研究

崔 然 皓 · 吳 鳳 國
서울大學校 農科大學

摘 要

產卵種鷄의 卵重을 改良하기 위하여 卵重에 對한 遺傳力과 遺傳相關등의 遺傳的 母數를 推定한 후 白色 레그혼種 2系統(A, K)에서 週齡에 따른 卵重의 增加樣相을 살펴보았다. 또한 選拔에 의한 遺傳的 改良量을 크게 하기 위하여 早期選拔을 실시할 경우 早期選拔의 最適時期를 찾아내는 것이 重要하므로 年 平均卵重에 對한 各 期間別 卵重의 相關關係와 아울러 回歸關係를 分析하여 最適 選拔時期를 알아 보았고 各 期間別 選拔에 의한 改良量을 相對的으로 나타내므로써 早期選拔에 對한 妥當性을 究明하고자 本 試驗을 수행하였으며 얻어진 結果는 다음과 같다.

週齡이 늘어남에 따라 卵重도 增加하였는데 產卵初期에서는 增加量이 컸지만 점차 감소하였으며 回歸方程式으로 나타낸 增加量은 A, K系統에서 週當 各各 0.46g과 0.83g이었다. 年 平均 卵重에對한 各 期間別 卵重의 回歸係數는 29~32週齡의 平均卵重이 0.86(A), 0.88(K)로 나타나 가장 큰 數値를 보였다. 45~48週齡의 平均卵重을 기준으로 했을 때의 選拔에 對한 各 期間 平均卵重의 選拔相對效率에서는 A系統에서 33~36週齡, K系統에서 29~32週齡의 推定値가 가장 크게 나타나서 이 時期에서의 早期選拔에 對한 妥當性을 보여주었다.

I. INTRODUCTION

A number of previous investigators who researched egg weight have found that the heritabilities of this trait was high and it was positively and low negatively correlated with body weight and egg production. But very little works were published on the pattern of increase in egg weight with age and change of genetic gain by early selection based on part record.

Cowen *et al.* (1964) reported that pullet egg size increased at the rate of 2.2 gram per month from first egg to 7 or 8 months of age and increasing pattern was different in three genetically heterogenous control strains. And according to Han and Ohh (1975), it was suggested that egg weight increased linearly with age at the rate of 2.0 gram per month for about 6 or 7 months after commencement of laying and it tended to remain after that time.

The object of this study was to find out the pattern of increase in egg weight with age and the optimum age of selection to maximize the genetic gain by early selection.

II. MATERIALS AND METHODS

Two lines of Single Comb White Leghorn used for this study were expressed "A" and "K", which have been raised at College of Agriculture, Seoul National University since 1976. The two lines were derived from the superior foreign flocks as the synthetic lines. In each generation, the selection has been practised for egg number and egg weight avoiding full or half matings. The data were collected during two generations from 1978 through 1979. The birds studied were restricted to those pullets which had records for egg weight of full periods. The number of sires, dams and progenies in two lines used for the analyses were given in Table 1.

Table 1. Number of sires, dams and progenies in lines A and K for 2 years

Line	A			K		
Year \ Item	Sire	Dam	Progeny	Sire	Dam	Progeny
1978	15	74	348	5	15	68
1979	13	76	232	8	32	139
Total	28	150	580	13	47	207

The characteristics chosen for analyses and their symbols were as follows.

Mean egg weight from first egg to 24 weeks ; E W 22
Mean egg weight from 25 weeks to 28 weeks ; E W 26
Mean egg weight from 45 weeks to 48 weeks ; E W 46

The data were analysed separately for each line according to the following linear model.

$$Y_{ijkl} = \mu + Y_i + S_{ij} + D_{ijk} + e_{ijkl}$$

Where,

Y_{ijkl} = the observation of the l^{th} progeny from the k^{th} dam and the i^{th} sire in the i^{th} year.

μ = population mean
Y_i = effect of the i^{th} year
S_{ij} = effect of the j^{th} sire in the i^{th} year
D_{ijk} = effect of the k^{th} dam mated to the j^{th} sire in the i^{th} year
e_{ijkl} = effect of the l^{th} progeny within the k^{th} dam and j^{th} sire in the i^{th} year

Estimates of heritabilities can be obtained from the estimated components of variances as described for poultry data by King and Henderson (1954). The equations were;

$$h^2_{S+D} = \frac{2\,(\sigma^2_S + \sigma^2_D)}{\sigma^2_S + \sigma^2_D + \sigma^2_W}$$

Where,
σ^2_S = Component of variance between sires
σ^2_D = Component of variance between dams
$\sigma_W{}^2$ = Component of variance between full-sibs

Estimates of genetic correlation were obtained in analogous fashion from the covariance components by the methods of Friars et al. (1962) and Becker (1975).
The algebraic equations were;

$${}_{ij}r^G = \frac{{}_{ij}\sigma_P + {}_{ij}\sigma_D}{\sqrt{({}_i\sigma^2_S + {}_i\sigma^2_D)\;({}_j\sigma^2_S + {}_j\sigma^2_D)}}$$

Where,
$_{ij}r$ = genetic correlation between trait i and j from the full-sib components of variance and covariance.
$_{ij}\sigma$ = covariance components for sire between trait i and j.
$_{ij}\sigma$ = covariance components for dam between trait i and j.

III. RESULTS AND DISCUSSION

1. Increase in egg weight with age

The pattern of increase in egg weight with age in two lines, A and K, was presented in Figure 1.

By Figure 1, it could be inferred that the amount of increase was different with age. And while the amount was large in the early part of the laying year, it was decreased gradually. Estimated regression equations of egg weight (Y) on weeks (X) in lines and K were

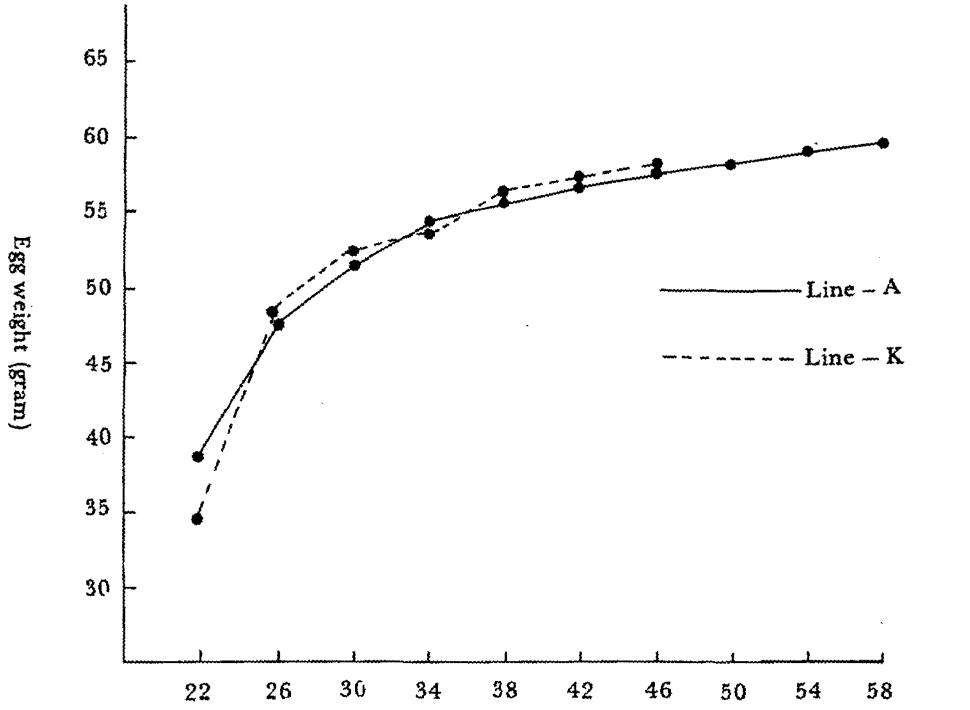

Fig. 1. Increase of egg weight with age in line A and K

Line A : $Y = 0.4594\,X^{**} + 35.4533\ (X \geqslant 22)$

Line K : $Y = 0.8292\,X^{**} + 23.3041\ (X \geqslant 22)$ $^{**}; P < 0.05$

According to the regression equations, it might be figured out that the amount of increse per week was about 0.46 gram and 0.83 gram in lines A and K, respectively. High value in line K was caused to large increase at the time in the period of laying commencement. The figure in line A was consistent with the results of Cowen *et al.* (1964), and Han and Ohh (1975) who reported 0.55 gram per week, 0.51 gram per week, 2.0 gram per month respectively.

2. Regression Coefficients

Regression coefficients and their F-values in each period mean egg weight on annual mean egg weight in two lines were presented in Table 2.

Through the correlation analysis of data used in this study, it was suggested that the coefficient of EW 34 that was mean egg weight from 33 weeks of age to 36 weeks of age had the highest value in genetic correlations with annual mean egg weight (Choi and Ohh, 1983).

Regression analysis was conducted to find out the relationships of each period mean egg weight with annual mean egg weight indirectly. And in Table 2, it could be inferred that mean

Table 2. Regression coefficients and F-values of each period mean egg weight on annual mean egg weight in lines A and K (data pooled over 2 years)

Line / Item / Trait	A		K	
	Regression coefficient and standard error	F-value	Regression coefficient and standard error	F-value
EW 22	0.2185 ±0.0119	334.98	0.1508± 0.0085	312.79
EW 26	0.8489 ±0.0228	1381.40	0.7455 ±0.0764	95.25
EW 30	0.8607 ±0.0222	1504.43	0.8786 ±0.0734	143.30
EW 34	0.8336 ±0.0198	1775 80	0.3387 ±0.0462	53.72
EW 38	0.8106 ±0.0192	1774.50	0.7211 ±0.0645	124.98
EW 42	0.7949 ±0.0198	1607.83	0.7537 ±0.0680	122.81
EW 46	0.7457 ±0.0218	1166.80	0.6745 ±0.0698	93.42

* All F-values are highly significant at 0.5% level ($P < 0.005$).

egg weight from 29 weeks of age to 32 weeks of age, EW 30, had the greatest influence on annual mean egg weight. Also the remarkably high figures in F-value of regression coefficients except EW 34 in line K suggested the validity of these coefficients. According to the results obtained by regression and genetic correlation analyses, the feasibility of early selection prior to 34 weeks of age could be supposed.

3. Relative selection efficiency

It has been pointed out by Dempster and Lerner (1947) and Lerner and Cruden (1948) that more rapid improvement in egg production would result from the use of pullet breeders rather than yearling hens. This conclusion was based on the fact that while only about two-thirds as much gain per generation would result from selection on number of eggs to the end of December as would be expected if selection were based on the full annual record, the generation interval would be only half as long, so that the actual gain per unit of time would be greater.

In the same way, the assumption that it could be used in case of egg weight led to calculate by relative selection efficiency as Table 2. The method for calculation was similar to that used by Lerner and Cruden (1948) and Oliver *et al.* (1957).

The constants computed to this point permit prediction of the rates of gain expected in the character under selection. The actual rate will, of course, depend on the intensity of selection as well as on the method of selection practised. However the relative efficiency of selection on the basis of part record may be established very readily. For each standard deviation in the generation is h in the limit. If the criterion of selection is not the character itself but a correlated character, the rate becomes $h_X\, r_{GS,GX}$ where the last term is the genetic correlation between the character selected and the trait desired (Lerner and Cruden, 1948).

In Table 3, the relative genetic gains and relative selection efficiency per generation and per year were calculated in lines A and K. Genetic parameters and the trait in which gain was desired were from sire + dam component and EW 46.

Table 3. Expected genetic gain and relative selection efficiency per generation and per year in EW 46 when selection is based on different measures of egg weight in lines A and K.

Line / Basis of Selection	A			K		
	Genetic gain/ Gen.	Selection effi./ Gen.	Selection Year	Genetic gain/ Gen.	Selection effi./ Gen.	Selection Year
EW 22	0.079	0.109	0.218	0.028	0.036	0.072
EW 26	0.527	0.725	1.450	0.709	0.9111	1.822
EW 30	0.654	0.900	1.800	0.825	1.060	2.120
EW 34	0.694	0.955	1.910	0.483	0.621	1.242
EW 38	0.674	0.927	1.854	0.777	0.999	1.998
EW 42	0.655	0.901	0.901	0.812	1.044	1.044
EW 46	0.727	1.000	1.000	0.778	1.000	1.000

IV. SUMMARY

The records on 787 white Leghorn hens from two different strains, A and K were used in this study to find out the pattern of increase in egg weight with age and the optimum age of early selection for maximizing the genetic gain.

The pattern of increase in egg weight with age in two lines which was expressed on graph showed that the amount of increase was larger in the early part of the laying year and it decreased gradually. Regression equations suggested that egg weight increased linearly with age at the rate of 0.46 gram per week for line A and 0.83 gram for line K. And in the regression analyses of each period mean egg weight on annual mean egg weight, the coefficients of EW 30 that is mean egg weight from 29 weeks of age to 32 weeks of age were 0.86 for line A, 0.88 for line K, and those were the highest figures among the all regression coefficients of each mean egg weight on annual mean egg weight.

In estimating the relative selection efficiency of each period mean egg weight on annual mean egg weight in EW 46, selection on EW 34 for line A and on EW 30 for line K was the most efficient for improving egg weight. These results suggested that one periods from 29 weeks of age to 36 weeks of age could be used for the best predictable time for improving annual mean egg weight.

V. REFERENCES

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