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GENETIC PARAMETERS STUDIED IN LEGHORN LINE 004C

PARAMETRII GENETICI STUDIAȚI ÎN CADRUL LINIEI LEGHORN 004C

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The purpose of the study was to determine the genetic parameters because they vary from one line to another and from one generation to the next, to enable us observe the genetic basis of selection in the surveyed line. The following genetic parameters were studied: heritability (0.0147 for the age at the first egg), egg production (h^2 = 0.067); egg weight at 26 de weeks (h^2 = 0.17and at 34 weeks (h^2 = 0.137. The estimated value for the body weigh heritability was 0.302; the production index had a heritability of 0.128. The genetic correlations of the surveyed traits ranged between -0.5116 for the trait pair egg production and body weight at 34 weeks; 0.8992 for the trait pair egg weight at 26 weeks and at 34 weeks. The phenotypic correlations ranged between -0.3451 and 0.7272 for the trait pairs: body weight and production indicator; egg production and production indicator. The environmental correlations had a minimum value of -0.3121 for the trait pair body weight and production indicator; the maximal value was observed for the trait pair egg production and production indicator. The knowledge of the phenotypic, genetic and environmental correlations of the economically-important traits was required by the establishment of a correct selection basis for the simultaneous improvement for two or more traits. The surveyed parameters outline quantitatively and qualitatively the improvement of line 004C used for the production of Albo SL 2000 hybrid.

Key words: genetic parameters, heritability, genetic correlations, age at first egg, egg production, egg weight, body weight

Introduction

The study of the production traits of the layer populations has been always important to the accomplishment of the improvement goals both in biologic and economic terms, displayed as efficiency after selection. Much research was done on the variation of the genetic parameters.

The purpose was to determine the genetic parameters because they vary from one line to another and from one generation to the next, to enable us observe the genetic basis of selection in the surveyed line. There are differences between the values of heritability and of the obtained correlations due to the low additive variability after the intensity of the selection practiced within the pure lines, such as this line. As we know, the improvement programs have several traits as objective of improvement and we have to know the genetic correlations between them, the environmental influence which also induces differences, and we also have to know the phenotypic correlations. All the studied parameters outline quantitatively and qualitatively the process of improving line 004C used to produce Albo SL 2000 hybrid.

Material and Methods

The surveyed biological material consisted of 004C line layers produced by S.C. Avicola Bucureşti S.A. at the centre for selection, hybridizing and distribution from Mihăileşti and it participates in the development of Albo SL 2000 hybrid. This hybrid produces white shelled eggs. It originates from lines 4Z, 2G and 4C, homozygous for the fast feathering gene and from line 4X homozygous for the slow feathering gene. All 4 lines belong to Leghorn breed.

The working methods are described below.

Table 1 shows the analysis pattern for the variance with three sources of variation.

Table 1

Total variance breakdown into observational components

Source of variation	**Degrees of freedom**	**Sum of squares**	**Square mean**	**Observational components**
Between fathers	T-1	$\sum_i \frac{(\sum\sum_{jk} X_{ijk})^2}{\sum_j n_{ij}} - \frac{(\sum\sum\sum_{ijk} X_{ijk})^2}{\sum\sum_{ij} n_{ij}}$	$\frac{SP_T}{T-1}$	$S_T^2 = \frac{MP_T - MP_D - \frac{K_2}{K_1}(MP_M - MP_D)}{K_3}$
Between mothers to the same father	M-T	$\frac{(\sum_k X_{ijk})^2}{n_{ij}} - \sum_i \frac{(\sum\sum_{jk} X_{ijk})^2}{\sum_j n_{ij}}$	$\frac{SP_M}{M-T}$	$S_M^2 = \frac{MP_M - MP_D}{K_1}$
Between offsprings to the same mother	D-M	$\sum\sum\sum_{ijk} X_{ijk}^2 - \sum\sum_{ij} \frac{(\sum\sum_{k} X_{ijk})^2}{n_{ij}}$	$\frac{SP_D}{D-M}$	$S_D^2 = MP_D$
Total	D-1	$\sum\sum\sum_{ijk} X_{ijk}^2 - \frac{(\sum\sum\sum_{ijk} X_{ijk})^2}{\sum\sum_{ij} n_{ij}}$	$\frac{SP}{D-1}$	$S_{TOTAL}^2 = S_T^2 + S_M^2 + S_D^2$

The statistical model to calculate the observational components of the covariation is identical with that of variance except that the square deviation for each parameter is replaced by the product of the deviations of the pair of studied traits.

The method of the causal components of the variation was used to determine heritability, knowing that by this method:

$h^2 = V_A / V_F$

Knowing that $V_A = 4\ S^2_{fathers}$, we relate V_A / V_F and we obtain the value of the heritability coefficient. The error of heritability was calculated with the simplified method of: $s_{h^2} = (h^2 + \frac{4}{n_i}) \cdot \sqrt{\frac{2}{S}}$ in which S – number of families of half brothers / half sisters, n_i – average size of this family.

The phenotypic correlation is calculated starting from the phenotypic variances and covariances:

$$r_{F_{XY}} = \frac{\operatorname{cov}_{F_{XY}}}{\sqrt{S_{F_X}{}^2 \cdot S_{F_Y}{}^2}}.$$

The error of correlation is given by the relation of Fisher:

$$S_{r_{F_{XY}}} = \sqrt{\frac{1 - r_{F_{XY}}{}^2}{N-2}}.$$

The genetic correlation was evaluated starting from the component between fathers:

$$r_{G_{XY}} = \frac{\operatorname{cov}_{G_{XY}}}{\sqrt{S_{T_X}{}^2 \cdot S_{T_Y}{}^2}}$$

The error of correlation was calculated by the relation of de Reeve (1955) and Robertson (1959):

$$S_{r_{G_{XY}}} = \frac{1 - r_{G_{XY}}{}^2}{\sqrt{2}} \cdot \sqrt{\frac{S_{h_X{}^2} \cdot S_{h_Y{}^2}}{h_X{}^2 \cdot h_Y{}^2}}$$

The environmental correlation was estimated starting from the component between fathers:

$$r_{M_{XY}} = \frac{\operatorname{cov}_{E_{XY}} - 2\operatorname{cov}_{T_{XY}}}{\sqrt{(S_{E_X}{}^2 - 2S_{T_X}{}^2) \cdot (S_{E_Y}{}^2 - 2S_{T_Y}{}^2)}}$$

Results and Discussions

We surveyed the heritability for the following traits: age at first egg, egg production, egg weight at 26 and 34 weeks, body weight and production indicator (Table 2).

The age at first egg has a heritability of 0.0147; egg production $h^2 = 0.067$; egg weight at 26 weeks $h^2 = 0.17$ and at 34 weeks $h^2 = 0.137$. The estimated value for the body weigh heritability was 0.302; the production index had a heritability of 0.128.

Table 2

Analysed values of trait heritability and their error

Nr crt	**Trait**	**Heritability** $h^2 \pm s_h^2$
1	Age at first egg	0.0147 ± 0.017
2	Egg production	0.067 ± 0.026
3	Egg weight at 26 weeks	0.170 ± 0.0423
4	Egg weight at 34 weeks	0.137 ± 0.0376
5	Body weight	0.302 ± 0.063
6	Production indicator	0.128 ± 0.0350

The values obtained during this study were compared with the literature. For the egg production King and Henderson, 1954 (cited by Popescu-Vifor, 1978) obtained h^2 = 0.3, Merritt in 1968 found h^2 = 0.17, and Nordskog et al. 1975 reported h^2 = 0.08 for the number of eggs by tested layer. In a Leghorn line, Pricop F., 1985, found h^2 = 0.203, while Sandu et al., 1984 reported a heritability of 0.254 also in a Leghorn line.

Bețianu I. 1995, cited by Neagu Iuliana, 1996, reported a heritability of h^2 = 0.215 for a maternal Rhode Island line. Also for the egg production, Nistor Gh., 1995, reported values of the heritability for the four studied lines of: h^2 = 0.243; h^2 = 0.22; h^2 = 0.263 and h^2 = 0.280.

The hereditability of the egg weight at 34 weeks was evaluated by Lerner and Cruden (cited by Falconer, 1969) was h^2 = 0.6 while Hill et al. reported h^2 = 0.64. Regarding the egg weight, Sandu Gh., 1979 (cited by Neagu, 1996) reported h^2 = 0.59 in a Rock line. Bețianu I., 1995 obtained for the maternal and paternal line of Rhode Island values of heritability of h^2 = 0.287 and h^2 = 0.451. For the same trait, Nistor Gh., 1995 reported in the four studied lines a heritability of 0.542 for the Slow line, 0.562 for line 2, 0.53 for line 3 and 0.629 for line 4.

For the body weight trait, Lerner and Cruden1995, reported h^2 = 0.2. Sandu Gh., 1979, reported for a Rock population h^2 = 0.21, while Nistor Gh., 1995, observed the following values of hereditability for the four lines: Slow line h^2 = 0.216; line 2 h^2 = 0.271; line 3 h^2 = 0.269, and line 4, h^2 = 0.278.

Regarding the heritability for the age at the first egg, King and Henderson, 1954, (cited by Popescu-Vifor, 1978) reported h^2 = 0.5, while Bhren et al. 1981, (cited by Sandu, 1983) obtained h^2 = 0.28. Bețianu I. found for this trait h^2 = 0.139 in two Rhode Island lines, while Nistor Gh. reported: h^2 = 0.217 for the Slow line, h^2 = 0.231 for line 2, h^2 = 0.206 for line 3 and h^2 = 0.208 for line 4.

The six traits were correlated two by two and produced 15 phenotypic, genotypic and environmental correlations showed in Table 3**.**

The coefficients of genotypic correlation for the analysed traits range between 0.6185 and 0.8992; eight of the fifteen evaluated genetic correlations have negative values, the balance having positive values.

Table 3

Phenotypic, genotypic and environmental correlations evaluated in the studied line

Studied traits	Genotypic correlation	Phenotypic correlation	Environmental correlation
Egg production × egg weight at 26 weeks	-0.2118±0.209	0.2157±0.015	0.2888
Egg production × body weight	-0.3710±0.168	-0.0366±0.015	-0.0242
Egg production × age at first egg	0.3928±0.4006	0.4682±0.0135	0.4619
Egg weight at 26 weeks × body weight	0.3663±0.137	0.1376±0.0152	0.0741
Egg weight at 26 weeks × age at first egg	-0.1761±0.336	0.0875±0.0153	0.1391
Body weight × age at first egg	-0.0532±0.346	-0.0524±0.0153	-0.0513
Egg production × egg weight at 34 weeks	-0.5116±0.168	0.0882±0.0153	0.1618
Egg production × production indicator	0.5375±0.162	0.7272±0.0120	0.7527
Egg weight at 26 weeks × egg weight at 34 weeks	0.8992±0.0349	0.3827±0.0142	0.2852
Egg weight at 26 weeks × production indicator	0.1269±0.180	0.2280±0.0170	0.2540
Body weight × egg weight at 34 weeks	0.5277±0.003	0.1378±0.0152	0.0303
Body weight × production indicator	-0.6185±0.104	-0.3451±0.0164	-0.3121
Age at first egg × egg weight at 34 weeks	-0.3967±0.332	-0.0761±0.0153	-0.0284
Age at first egg × production indicator	-0.3669±0.163	-0.0178±0.0175	0.0116
Egg weight at 34 weeks × production indicator	0.0198±0.192	0.4161±0.0159	0.4872

There is a very tight correlation between the body weight and the production indicator, r_G = -0.6185, which shows that a layer which is too heavy will have twice as low production and a low production indicator. There is a very tight positive genotypic correlation between the egg weight at 26 weeks and at 34 weeks, r_G = 0.8892, showing that the layers producing large eggs at 26 weeks will also produce large eggs at 34 weeks. There also is a positive correlation between the egg production and the production indicator, showing that a layer with large production will also have a higher production indicator, r_G = 0.5375. There is a negative genetic correlation between egg production and egg weight at 34 weeks, r_G = -0.5116, showing that the layers with twice as large production will have eggs with lower weight. The coefficients of phenotypic correlation for the analysed traits range between -0.3451 and 0.7272; five phenotypic correlations are negative, the others are positive. There is a very tight positive phenotypic correlation between the egg production and the production indicator, showing that a layer with large production will also have a higher production indicator. There also is a positive phenotypic correlation between the age at first egg and the egg production, 0.4682, a precocious layer having a higher number of eggs at the end of testing. Slightly negative phenotypic correlations were obtained between the traits age at first egg and egg weight at 34 weeks, r_F = -0.0761; and age at first egg with body weight, r_F = -0.0524. There is a very tight negative phenotypic correlation between the body weight and the production indicator showing that a layer which is too heavy will have fewer eggs and therefore a lower production indicator. The values of the environmental correlations range between -0.3121 and 0.7527. There is a very tight negative environmental correlation between the body weight and the production indicator, r_M = -0.3121, showing that a layer which liver in proper environmental conditions will have a larger body weight and therefore a lower production of eggs. In a good environment there is a tight positive correlation between the traits for egg production and production indicator, r_M = 0.7527, a hen in a good environment will produce many eggs and will have a higher production indicator.

Conclusions

The values of the evaluated heritability for the traits studied in line 004C were in line with the literature data, as follows: age at first egg has a heritability of 0.0147; egg production h^2 = 0.067; egg weight at 26 weeks h^2 = 0.17 and at 34 weeks h^2 = 0.137. The estimated value for the body weigh heritability was 0.302; the production index had a heritability of 0.128. The *genotypic correlations* ranged between 0.6185 and 0.8992; eight of the fifteen evaluated genetic correlations have negative values, the balance having positive values. There is a very tight correlation between the body weight and the production indicator, r_G = -0.6185, which shows that a layer which is too heavy will have twice as low production and a low production indicator.

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The *values of the phenotypic correlations* for the analysed traits ranged between -0.3451 and 0.7272, five phenotypic correlations being negative, the others positive. There is a very tight positive phenotypic correlation between the egg production and the production indicator, showing that a layer with large production will also have a higher production indicator.

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The *values of the environmental correlations* ranged between -0.3121 and 0.7527. There is a very tight negative environmental correlation between the body weight and the production indicator, $r_M = -0.3121$, showing that a layer which liver in proper environmental conditions will have a larger body weight and therefore a lower production of eggs. In a good environment there is a tight positive correlation between the traits for egg production and production indicator, $r_M = 0.7527$, a hen in a good environment will produce many eggs and will have a higher production indicator.

Bibliography

1. **Bețianu I**. (1995) –*Studiul privind dinamica genetică a celor două linii care concură la formarea hibridului Roso SL*. Teză de doctorat U.S.A.M.V. Bucureşti

2**. Falconer, D**.**S**. (1967) -*Introducere în genetica cantitativă, (traducere după Introduction to quantitative genetics*, Oliver and Boyd, LTD, Edinburg and London, ed. Agrosilvică, buc.

3. **Neagu Iuliana** (1996) –*Cercetări privind istoria şi dinamica genetică a unei linii de găini*. Teză de doctorat U.S.A.M.V. Bucureşti

4. **Popescu Vifor, Şt**. (1978) - *Genetica animală*. Ed. Ceres, Bucureşti

5. **Popescu Vifor, Şt. Şi Poşircă D**. (1981) -*Studiul comparativ al parametrilor genetici ai unor caractere referitoare la producția de ouă la două populații de găini*, Lcr. Şt. I.A.N.B., seria D, vol. XXIV, pg. 59-64

6. **Pricop F**. (1985) -*Parametrii genetici şi indici de selecție la liniile genitoare de hibrizi de ouă*. Teză de doctorat

7. **Robertson, A**. (1959)– *Laboratory breeding experiment and animal improvment*. Congress Genetic vol. I

8. **Robertson, A**. (1959)– *Experimental design in the evaluation of genetic parameters.* Biometrics, nr.15

9. **Robertson, A**. (1959)– *The sampling variance of the genetic correlation coefficient*. Biometrics, nr.15

10. **Sandu, Gh.** (1979) – *Cercetări privind parametrii genetici, construirea unor indici de selecție şi implicațiile folosirii lor în tehnologia ameliorării unei populații de găini*. Teza de doctorat. Bucureşti 1979

11. **Sandu, Gh**. (1983)– *Genetica şi ameliorarea păsărilor*. Ed. Ceres, București