Heterosis of different egg-laying traits, in reciprocal crosses of brown egg-layers

Heterosis para distintos caracteres de producción, en cruzas reciprocas de ponedoras de huevos de cáscara marrón

H. Willeke*

Federal Republic of Germany

In poultry breeding heterosis is of major interest, as the pure line performance in egg-production traits of two lines can be exceeded by 20 percent by the crosses of them (FLOCK, 1980; MORRIS & BINET, 1966; SHERIDAN & RANDELL, 1977).

This study was designed to identify differences in the heterosis of two reciprocal crosses in egg number, egg weight, egg mass, feed consumption, feed conversion and mortality.

Material and Methods

This study was conducted with two experimental lines (AA and BB) and its reciprocal crosses (AB and BA) of a private breeding company. 30 pure line cockerels had been mated to 4 hens of its own and 4 hens of the other line. The chicken were reared under normal conditions. At an age of 20 weeks 1150 were housed in group cages at the Research Farm Wildschwaige of the Lehrstuhl für Tierzucht Freising-Weihenstephan.

The chicken house has two sections with different cage types; therefore each family was split and hens were caged in each room. The distribution of the lines in the rooms was as follows:

Table 1: Distribution of the cages in the rooms

Room	Birds per cage	Line			
		AA	AB	BA	BB
1	3	62	63	63	52
2	2	53	58	53	51

The birds were fed a normal diet of a commercial feed mill, which doesn't exclude that between the mixtures differences in the energy content of the ratio existed.

*Lehrstuhl für Tierzucht der Technischen Universität München, 8050 Freising-Weihenstephan, FRG

Table 2: Comparison of the means ($\mu + \alpha_i$) two lines and their contemporary reciprocal crosses for different production traits of a 48-weeks laying period.

Trait	P-Lines AA	P-Lines BB	F_1-Lines AB (♂ x ♀)	F_1-Lines BA (♂ x ♀)	Variance ratio (F-test)
Egg number (hen housed)	271.9	243.3	270.0	267.3	27.6**[1)]
Average egg weight (g)	61.4	62.5	62.7	61.6	3.5*
Egg mass (kg)	16.54	14.98	16.74	16.31	22.8**
Feed consumption (kg)	40.72	39.10	41.01	40.49	6.2**
Feed conversion 1 :	2.48	2.65	2.47	2.50	7.5**
Body weight with in age					
24 weeks (kg)	2.007	1.986	2.036	2.012	1.0
60 weeks (kg)	2.301	2.242	2.314	2.365	3.9**
Mortality rate (%)	5.8	5.4	7.1	8.7	11.9**[2)]
Number of cages	115	103	121	116	

1) * $p \leq .05$, ** $p \leq .01$

2) due to a Chi-Square-test

Table 3: The mean of the parental lines and the heterosis (%) of the F_2 crosses for the different traits

Trait	$\bar{P}$	Heterosis (%) F_1 (AB)	Heterosis (%) F_1 (BA)	F_1
Egg number (hen housed)	257.6	4.8	3.8	4.30
Average egg weight	62.0	1.1	-.6	.25
Egg mass	15.76	6.2	3.5	4.85
Feed consumption	39.91	2.8	1.5	2.15
Feed conversion 1 :	2.57	-3.9	-2.7	-3.3

The data has been collected in a 4-week rhythm. The eggs has been collected daily. 6 days per week feed supply in each cage was checked and the number of cups needed per trough was recorded.

At the end of each 4 week period the residual feed of each cage has been reweighed and the feed consumption of each cage in that period calculated. Furthermore in the middle of each 4-week period the eggs of each cage were collected for two days and weighed. The egg mass per period and the food conversion (food consumption/egg mass) were calculated. Furthermore, the hens were weighed of an age of 24 and 60 weeks. The experiment extended over 12 4-week periods.

The least squares analysis was based on the following model:

$$y_{ijk} = \mu + L_i + s_{ij} + H_k + e_{ijkl}$$

where

y_{ijkl} = the cage average in the k^{th} house of j^{th} sire within the i^{th} line

μ = overall mean

L_i = the fixed effect of the line, i = 1,2,3,4

s_{ij} = the random effect of the sire within the line j=1,,,30

H_k = the fixed effect of the house, k=1,2

e_{ijkl} = random error

The sire was nested within the line as the number of cages per sire was different. In a pre-test the data has been analysed according to a model which included only the fixed effects and the interaction between both; as the interaction has not been significant, it was ignored in the above described model.

Results and discussion

The two pure lines (table 2) differ in egg production very markedly. The difference of 28.6 eggs between the lines AA and BB is highly significant ($p \lesssim .01$). The F_1 crosses show distinct heterosis without reaching the egg number of the AA line. Figure 1 shows the egg number of the different lines and crosses in the 12 4-week-periods. The difference in egg laying between the lines AA and BB is consistent over the whole laying period.

There are significant differences between the egg weights of lines AA & AB and AA & BA respectively. The crosses produced nearly the same egg weights as their dam lines. The differences between the crosses cannot be explained by sex linkage, it could be due to maternal effects, as demonstrated by LOWE and GARWOOD (1981). In broiler breeding a direct effect of the size on the embryonic and post-embryonic growth had been observed (AL-MURRANI, 1978). In our experiment the date of hatching and the rearing has been the

Fig.1 Egg-number per 4-week-period

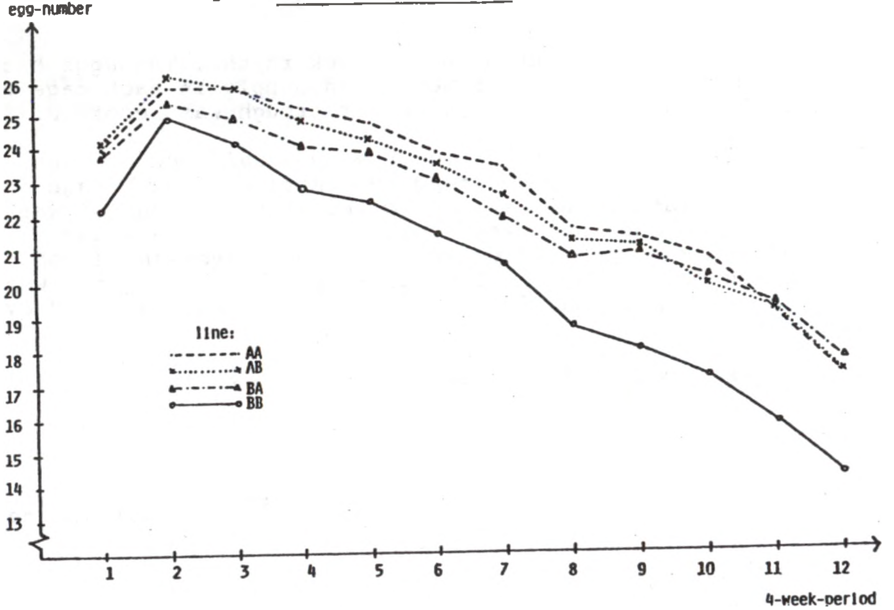
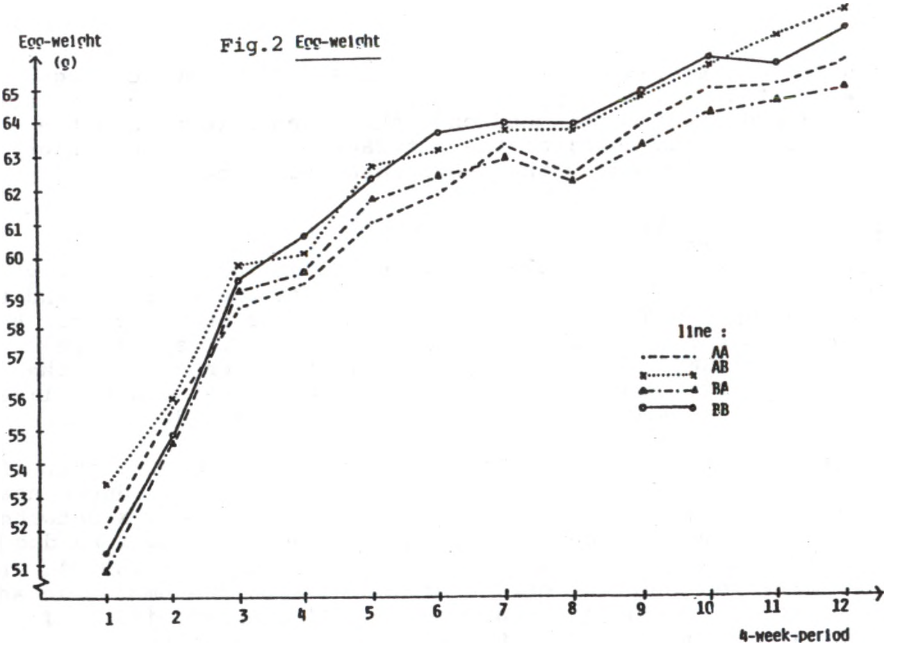


Fig.2 Egg-weight



same for all the lines. Therefore the possibility exists that the chickens out of larger eggs were heavier, and that this difference persisted to the laying period. There the hens originating out of eggs of the BB hens had a better starting position, which benefited their weights so that they produced heavier eggs. This hypothesis is supported by the body weights. There is a pronounced difference between the weights of the line AA and BB with an age of 60 weeks, but no difference with an age of 24 weeks.

If we assume that the 60-weeks weight is identical with the adult weight, the birds of the lines AA, BB, AB and BA had with 24 weeks 87 %, 89 %, 88 % and 85 % of their adult weight, respectively, which shows a similar influence of the maternal line on the weight as in egg weight.

The heterosis in egg mass exceeded the heterosis in egg number and egg weight. The difference between the two crosses (2,7 %) is mainly due to the difference in egg weight.

The differences between the lines in feed consumption can mainly be explained by the differences in egg mass and body weight of an age of 60 weeks. In this context the lower heterosis in the cross BA (1,5 %) is more desirable than the higher one in AB. Feed conversion (table 3) shows medium heterosis with differences between the two crosses of 1,2 %.

It was surprising, that mortality rate showed heterosis in the unexpected direction, for the crosslines had higher mortality rates than the pure lines.

In egg production heterosis can reach 20 per cent (MORRIS & BINET, 1966; FLOCK, 1980). The heterosis in the lines of FLOCK was probably increased by a long term RRS selection, which had increased the overdominance of these two line crosses (PIRCHNER & MERGL, 1977). In comparison to these results the heterosis estimates of this study (table 3) are rather low. Nevertheless it may be of interest that differences in reciprocal crosses occured, which may be due to maternal effects, although no prove is possible, whether this differences in the egg weights of the reciprocals is due to a heavier hatching egg or to antibody transmission through the eggs as NORDSKOG and PEVZNER (1977) have shown.

Summary

For estimating the heterosis the performance of two pure lines hens and its reciprocal crosses had been compared in the egg production traits. The data of 1150 hens had been collected for a laying period of 48 weeks.
Considerable heterosis was found in egg number (4.3 %), egg mass (4.85 %), feed consumption (2.15 %) and feed conversion (-3.3 %). There was a significant difference between the egg weights of the reciprocal crosses. The egg weight of the crosses tended to the egg weight of the dam line.

Resumen

Para estimar la heterosis, se comparó el rendimiento de dos lineas puras de gallinas, así como el de sus cruzas recíprocas, en caracteres de produción de huevos. La información de 1150 gallinas corresponde a un período de producción de 48 semanas. Se econtró una considerable heterosis en el número (4.3 %) y peso (4.85 %) de los huevos, y en el consumo (2.15 %) y converión (-3.3 %) de alimento. La diferencia entre el peso de los huevos de las cruzas recíprocas, resultó significativa. El peso del huevo de las cruzas mostró una tendencia hacia el peso del huevo de la línea materna.

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