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Heterosis in egg production in different parts of the laying period of layers of Rhode Island Red origin selected by RRS selection in two environments
Part. II. Heterosis in hen day egg production in populations under long term RRS selection

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ABSTRACT

In the trial reported the parental strains and their reciprocal crossbred progeny are Rhode Island Red highly productive commercial populations selected for over 20 generations by RRS. Heterosis in hen day egg production was measured in four independent part periods 90 days each covering the whole 360 days egg production cycle, starting from the day of the populations reached 50% egg production. All parental and crossbred hens were housed 2 and 4 birds to a cage. From each pure strain 10 unrelated cocks were mated to 10 unrelated pullets each, to produce purebred and crossbred progeny. The experiment was conducted as an orthogonal randomised factorial trial, sires were regarded as random, mating (cross vs. pure) and density (2 vs. 4 hens per cage) as fixed effects. A total of 20 parental halfsib groups of 64 (16-16 purebred 2 vs. 4 hens/cage, 16-16 crossbred 2 vs. 4 hens/cage) birds each completed the experiments. Heterosis was significant (P<0.001) in all part periods in both environments. The heterosis in hen day egg production during the part periods 1-90, 91-180, 181-270 and 271-360 days in production respectively were: 2 hens per cage: 4.10, 3.74, 5.02 and 6.37; 4 hens per cage: 4.09, 3.29, 2.16 and 3.40. In optimal environment the mean heterosis across periods was 4.81, under suboptimal environment it was reduced to 3.23 eggs per part period. Reduced heterosis was clearly evident for the second part (180 days onward) of the egg production cycle. The relative magnitude (%) of heterosis declines sharply in suboptimal environment compared to the performance measured under optimal conditions during the periods 180-270 (3.38-7.43%) and 271-360 days (6.04-10.76%) in lay. The increased stocking rate depressed hen day egg production significantly (<0.001) in all part periods of the egg laying cycle and density × mating interaction were significant (P<0.05) only in two last part periods. The results indicate that the present day high performing layers selected for more than 20 generations by RRS react differently compared for to their ancestors two decades ago.
(Keywords: heterosis, egg production, part periods, commercial strains, RRS selection)

ÖSSZEFOGLALÁS

A tojástermelésben mutatkozó heterózis az RRS módszerrel szelektált Rhode Island Red tojótyúkok különböző termelési periódusában, két eltérő környezetben II. A tojástermelésben tapasztalt heterózis hosszú ideig végzett RRS szelekció utáni populációban

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A kísérletben a szülői vonalak, valamint a reciprok keresztezett Rhode Island Red 20 generáción keresztül szelektált kereskedelmi populációk tojástermelését vizsgáltuk. 90-360 napos tojástermelési ciklus, 4 egymástól független periódusában, vizsgáltuk a tojástermelésben a heterózis nagyságát. A kísérletet akkor kezdtük amikor a populációk tojástermelése elérte az 50%-os szintet. Az összes szülő és keresztezett állományt 2-4 férőhelyes ketrecekben helyeztük el. Mindegyik tisztavonalból, 10 rokonságban nem lévő kakast 10 rokonságban nem lévő jércéhez párosítottunk a tisztavérű és a keresztezett állomány előállítása érdekében. A kísérletet ortogonális, véletlenszerű, faktoriális módon végeztük, ahol a szülőket véletlenszerűnek tekintettük, a párosítási módszerek - keresztezett, tisztavérű, valamint a 2 és 4 tojótyúk/ketrec telepítési sűrűség - voltak a fix hatások. A 64 madár 20 apai féltestvér egyede (16-16 tisztavérű, 2-4 tojótyúk/ketrec, 16-16 keresztezett 2-4 tojótyúk/ketrec) vett részt a kísérletben. A tojástermelés minden szakaszában, valamint minden környezetében szignifikáns (P<0,001) heterózis hatást mutattak ki. A tojástermelés különbözők szakaszai (1-90, 91-180, 181-270 és 271-360 nap) alatt a heterózis nagysága az alábbiak szerint alakult: 2 madár/ketrec: 4,10; 3,74; 5,02 és 6,37; 4 madár/ketrec: 4,09; 3,29; 2,16 és 3,40 tojás. Optimális környezeti feltételek között a heterózis átlagos nagysága 4,81 tojás volt, amely szuboptimális környezeti feltételek mellett 3,23 tojásra csökkent. A heterózis csökkenése különösen nyilvánvaló volt a tojástermelési ciklus 2. szakaszában (180 nap alatt). A heterózis relatív nagysága (%) meredeken csökkent a szuboptimális feltétetlek mellett az optimális viszonyokhoz hasonlítva a tojástermelési periódus 180-270. napja (3,38-7,43%) és a 271-360. napja között (6,04-10,76%). A növekvő állatsűrűség szignifikánsan (P<0,001) csökkentette a tojástermelési ciklus mindegyik szakaszában a tojás mennyiségét, a telepítési sűrűség x párosítás interakció viszont csak az utolsó két periódusban volt szignifikáns (P<0,05). A kísérleti eredmények azt bizonyítják, hogy a 20 generáció óta RRS-sel szelektált, nagy teljesítményű tojótyúkok másként reagálnak a változásokra, mint a két évtizeddel korábban élt őseik.

(Kulcsszavak: heterózis, tojástermelés, részperiódusok, kereskedelmi vonalak, RRS szelekció)

INTRODUCTION

Reports evaluating short and long term genetic trends in laying hens using the same populations selected for many generations are very rare (*Sharma et al*., 1998). To the authors best knowledge there has been no reported attempt to compare the performance of pure commercial, highly productive parental lines and their crosses in two environments at two stages of their selection history 20 years apart except that of *Horn et al.* (1998). *Horn et al.* (1998) reported on heterosis in annual hen day egg production, egg weight, body weight and sexual maturity, measured in reciprocal crosses of two Rhode Island Commercial strains tested first in 1977-1978 and repeatedly in 1997-1998 under the same environmental conditions. No comparisons have been made however in hen day egg production for 4 independent part periods of the 12 months laying cycle. Earlier we presented data referring to the initial 1977-1978 generation of the same Rhode Island Red type commercial lines and crosses being selected since only for a few generations by RRS.

In the present paper we analyse the hen day egg production data the 12 month egg production year split into four part periods of 90 days each of the same Rhode Island strains and their crosses after 20 years of continuous RRS selection (*Lorenz*, 1996) elapsing since the previous test reported (*Kamali et al*., 2001).

MATERIALS AND METHODS

Stocks and treatments

The Rhode Island strains (R and Q) were identical to those described by *Kamali et al*. (2001). In this trial 10 unrelated cocks of line R and Q produced the pure and crossbred progeny. To each cock 10 randomly chosen hens have been mated. The size of the paternal half-sib groups were identical to that described in the first trial. All other managemental and technical parameters and methods used were the same as described by *Kamali et al.* (2001).

Egg production data collection

Data on egg production were collected daily for the total of 480 cages holding the experimental birds. The handling and collecting the data was identical as indicated by *Kamali et al.* (2001).

Statistical procedures

All statistical procedures and models used for analyzing the data were the same as described by *Kamali et al.* (2001). The only difference is that 10 sires were used, causing changes in degrees of freedom, and calculating the appropriate expected mean squares during ANOVA.

RESULTS AND DISCUSSION

In *Table 1* the means of the hen day egg production data for the pure and crossbred populations are presented for the groups housed 2 hens/cage. On *Table 2* these same parameters are tabulated for the groups housed 4 hens per cage. In both data sets the egg production period of one year is sub-divided to four 90 days part periods.

On *Table 3* the mean squares (MS) and their significance based on ANOVA for hen day egg production by periods of lay are summarized relevant to the means presented on *Table 1 and 2*. The Sire component proved to be significant ($P<0.05$-$P<0.001$) for all parts of the laying cycle indicating that additive genetic variation still play a role in determining hen day egg production in commercial lines which have been intensively selected for over 30 years by RRS selection. Our data confirm the statements of *Albers* (1998) indicating that genetic variability in egg production within commercial layer selection lines is still large, inclusive additive genes.

Table 1

Means of hen day egg production of the purebred and crossbred hen populations as affected by period of production in optimal environment

Genotypes(1)	Hen day egg production 2 hens/cage(2)					
	QQ	RR	Av. Purebreds	QR	RQ	Av. Crossbreds
Periods(3)	74.12	70.79	72.45	75.98	77.13	76.55
1-90						
91-180	76.61	69.52	73.12	75.60	78.13	76.86
181-270	71.45	63.52	67.48	71.37	73.64	72.50
271-360 days in production(4)	61.98	56.46	59.22	65.32	65.86	65.59

1. táblázat: A tisztavérű és keresztezett tojó populáció átlagos tojástermelése optimális környezeti feltétlek mellett

Genotípus(1), 2 Tojó/ketrec átlagos tojástermelése(2), Periódusok(3), 271-360 nap közötti termelés(4)

Mating system (M) as an indicator of general combining ability and the interaction Sire×Mating (S×M) component estimating special combining ability both determine the nature and magnitude of heterosis. Both M and S×M interaction were highly significant ($P<0.001$) for all part periods of the laying cycle in determining the variance of hen day egg production. The Density (D) component of variance was highly significant ($P<0.001$) in all part periods of the egg production cycle, and several interactions with D component reached the levels of significance ($P<0.05$) as S×D and M×D in four part periods.

The heterosis in absolute and relative (%) terms are summarized in *Table 4*. Heterosis in absolute and relative terms was larger in optimal environment (2 hens/cage) compared to groups producing under high density environment.

Table 2

Means of hen day egg production of the purebred and crossbred hen populations as affected by period of lay in suboptimal environment

Genotypes(1)	Hen day egg production 4 hens/cage(2)					
	QQ	RR	Av. Pure breds	QR	RQ	Av. Cross breds
1-90	72.00	69.65	70.82	74.70	75.12	74.91
91-180	74.36	66.30	70.33	72.58	74.67	73.62
181-270	68.31	59.39	63.85	66.20	65.82	66.01
271-360 days in lay	59.40	53.24	56.32	59.62	59.82	59.72

2. táblázat: A tisztavérű és keresztezett tojó populáció átlagos tojástermelése szuboptimális környezeti feltételek mellett

Genotípus(1), 4 Tojó/ketrec átlagos tojástermelése(2)

The hen day egg production of the crossbred populations exceeded that of the pure lines in all part periods, and the deviations from the mean were maximally 1.56 egg in the populations producing in cages with two birds, and 1.07 eggs when 4 hens were housed to a cage in any of the 90 days part periods. The magnitude of heterosis was the largest in relative terms (%) in the last part periods in both environments.

Table 3

Mean squares (MS) and their significance based on ANOVA for hen day egg production by periods of lay

Sources(2)	df	Periods (day)(1)			
		1-90	91-180	181-270	271-360
Sires (S)(3)	19	61.87***	102.00***	160.04***	167.79***
Mating (M)(4)	1	1340.99***	1006.78***	1030.83***	1910***
SxM	19	60.31***	186.94***	205.18***	152.52***
Density (D)(5)	1	213.91***	712.46***	2050.82***	1537.16***
SxD	19	24.86*	25.03 ns	44.87 ns	71.79*
MxD	1	0.01 ns	5.11 ns	164.22*	175.57*
SxMxD	19	25.69*	21.79 ns	19.56 ns	45.02 ns
Error(6)	240	14.41	21.38	42.65	39.89

***P<0.001, **P<0.01, *P<0.05, ns: non-significant (*nem szignifikáns*)

3. táblázat: Az ANOVA által számolt négyzet összegek, valamint azok szignifikancia szintje a napi tojástermelésre a különböző periódusok alatt

Periódus (nap)(1), Források(2), Szülők(3), Párosítási rendszer(4), Telepítési sűrűség(5), Hiba(6)

Table 4

Heterosis in absolute and relative terms in hen day egg production in the part periods in different environments

Periods(1)	Heterosis eggs/hen(2)		Heterosis (%)(3)	
	2 hens	4 hens	2 hens	4 hens
1-90 days	4.10	4.09	5.66	5.77
91-180 days	3.74	3.29	5.20	4.68
181-270 days	5.02	2.16	7.43	3.38
271-360 days	6.37	3.40	10.76	6.04
Mean:	4.81	3.23	7.26	4.97

4. táblázat: A napi tojástermelés abszolút és relatív heterózisa a különböző periódusok alatt, valamint eltérő környezeti viszonyok között

Periódus(1), Heterózis tojások/tojótyúk(2), Heterózis(3)

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