Genet Sel Evol (1992) 24, 171-177

Original article

Egg production response of sex-linked albino (s^{al}) and colored (S) hens to high and low light intensities during brooding-rearing

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(Received 6 September 1991; accepted 22 January 1992)

Summary – In order to study the response of albino genotype to different light intensities, sex-linked albino or silver female chicks hatched from heterozygous sires were distributed in 2 windowless chick rooms, one with a light intensity of about 1 lux, the other receiving 170 lux on average. At the age of 17 weeks all the pullets were submitted to a high level of light intensity of 210 to 480 lux. All the females were given 10 h light per 24 h till 17 weeks, then 14 h. Age at first egg of birds receiving high light intensity as chicks was 14 d earlier, their hen-day production was slightly superior, and their mean egg weight 1.5 g lower as compared to females receiving dim light. On an average, the albino gene depressed initial growth, retarded age at first egg by 5 d, lowered egg weight by 2 g, increased hen-day production by 5%, and lowered the frequency of pause days. With low light intensity during brooding-rearing, hen-day production of the albino hens was 7.5% higher than that of colored females and they gave 12.8 eggs more, similarly to a previous experiment. These advantages of albinos were attenuated with high light intensity in the juvenile period. However, there were no significant genotype × treatment interactions.

hen / sex-linked albino / egg production / light intensity

Résumé – **Réponse de la production d'œufs de poules albinos (s^{al}) et colorées (S) à l'intensité lumineuse en poussinière.** *En vue d'étudier la réponse du génotype albinos à différentes intensités d'éclairement, des poussins femelles albinos ou argentés (gène lié au sexe) issus de pères hétérozygotes ont été répartis dans 2 poussinières sans fenêtres, l'une avec une intensité lumineuse d'environ 1 lux, l'autre recevant en moyenne 170 lux. À l'âge de 17 semaines, toutes les poulettes étaient soumises à une forte intensité lumineuse, de 210 à 480 lux. Toutes les femelles étaient éclairées 10 h par 24 h jusqu'à 17 semaines, 14 h ensuite. L'âge au 1er œuf des poulettes ayant reçu une forte intensité lumineuse au stade juvénile était de 14 j plus précoce, leur intensité de ponte était légèrement supérieure, leur poids moyen d'œuf de 1,5 g plus faible par comparaison aux femelles soumises à un faible éclairement. En moyenne, le gène albinos abaissait légèrement la croissance précoce,* *retardait l'âge au 1^er^ œuf de 5 j, réduisait le poids de l'œuf de 2 g, augmentait l'intensité de ponte de 5% et diminuait la fréquence des jours de pause. Avec la plus faible intensité lumineuse en poussinière, l'intensité de ponte des poules albinos dépassait de 7,5% celle des femelles colorées et les albinos donnaient 12,8 œufs de plus. Ces avantages des albinos étaient atténués en présence d'une forte intensité lumineuse en période juvénile. Il n'y avait cependant pas d'interaction significative génotype × traitement.*

poule / gène lié au sexe albino / intensité lumineuse / production d'œufs

INTRODUCTION

In a previous paper (Mérat and Bordas, 1989) we compared egg production criteria for sex-linked albino (s^{a1}) or colored (S) hens of the same origin with exposure to high or low light intensity during the laying period. We showed that the albino hens were slightly inferior to the non-albinos with exposure to the lower light intensity but superior to those with exposure to the higher light intensity. Following this, we wanted to reverify the results obtained at high light intensity and further to examine the effects of lighting level during the brooding-rearing period.

MATERIAL AND METHODS

Genotypes

Female chicks were hatched from 13 heterozygous (S/s^{a1}) sires belonging to a medium-heavy brown-egg type line maintained segregating for the alleles s^{a1} (obtained in 1979 from RG Somes, University of Connecticut, CT, USA) and S (silver). The albinism allele being used in the present report is the one designated by Silversides *et al* (in press) as S^{a1-c}. These males were pedigree mated to 60 hens from a sex-linked dwarf brown-egg type line selected for egg production traits (Boichard, 1990, personal communication) and fixed for the $s+$ (gold) allele. The parents utilized were similar to those used for a previous experiment (Mérat and Bordas, 1989). About half the female progeny of this cross were of the s^{a1} genotype, and the other half were of the S genotype. In total, 175 females were hatched on 20/10/1989. They were sexed at 1 day-old and their genotype at the silver/gold locus was determined from eye color.

Experimental conditions

The chicks were raised in floor pens in a windowless house where they received 10 h light per 24 h. Each genotype within each sire family was distributed equally in 2 identical rooms; in one of them an average light intensity of 1.0 lux at the height of the birds (0.5 to 2.0 lux depending on measurement location) was provided by incandescent bulbs. In the other, 3 additional fluorescent tubes provided a mean light intensity close to 170 lux (150 to about 190 lux according to measurement location). This lighting regimen was constant until 17 weeks of age. During this period the chicks were given *ad libitum* a mash containing 180 g crude protein and 11.7 MJ metabolizable energy per kg. The temperature was maintained around 20°C after the age of 5 weeks. At the age of 17 weeks, the pullets were equally distributed, for each genotype and each light treatment received during brooding–rearing, into 4 identical rooms each containing 48 individual cages on 2 levels. In all these 4 rooms the hens received *ad libitum* a mash containing 155 g crude protein, 34 g calcium and 11.05 MJ metabolizable energy per kg. The temperature was 22°C ± 1°. The photoperiod was 14 h light per 24 h. The lighting intensity, obtained using fluorescent tubes, was uniformly high, corresponding to the "high" level used by Mérat and Bordas (1989). Its values in lux, measured in each room, averaged 484 and 456 for the upper cage level and 210 and 200 for the lower cage level at the beginning and at the end of the experimental period respectively. The 4 rooms showed very similar values.

Variables – statistical analyses

The different variables appear in table I. The egg number was recorded from the first egg laid by an individual hen to the end of the control period, *ie* 54 weeks of age. Per cent shell-less, double-yolked or cracked eggs, hen-day percent production, mean clutch length, and percent pause days (taken as at least 2 consecutive days without oviposition) were measured over the same period.

During a 28-day period between 33 and 37 weeks of age, after the peak of laying, feed intake (O) was individually recorded together with egg mass (E), body weight variation (ΔW) and mean body weight (W). Two derived variables were feed efficiency (O/E) and the residual component of feed intake (R) obtained as the difference between O and a predicted intake T from a multiple regression equation with the independent variables E, W and ΔW (Byerly *et al*, 1980). The equation was the following:

$$T = 86.9\,W^{0.5} + 1.66\Delta W + 0.89E - 1941$$

The mean egg weight was measured from a 2-week collection between the ages of 35 and 37 weeks.

RESULTS AND DISCUSSION

Concerning laying hens in individual cages, no effect was found associated with the level of the cages, in spite of the difference of light intensity mentioned above, and accordingly the 2 levels have been pooled in the following analysis.

Table I gives the mean values per genotype and lighting treatment and the statistical significance of the main effects and their interaction.

Figure 1 shows the laying curves for each experimental group till the end of the experimental period.

The mortality in the brooding-rearing period was low and is not presented in detail. The mortality from the age of 17 weeks till the end of the recording period totalled 16 hens (8.4%) and did not differ significantly either between treatments or between genotypes. The numbers of dead related to the numbers alive at 17 weeks

Table I. Mean values per genotype and light intensity in the juvenile period and statistical significance.

Variable	*Mean values*								*Significance of the effects*		
	Low light intensity		*High light intensity*		*Total*		*Total*				
	S (n=47)	s^{a1} (n=43)	*S* (n=40)	s^{a1} (n=45)	*Low int*	*High*	*S*	s^{a1}	*Light intensity*	*Genotype*	*Interaction*
8 wk body weight (g)	765	742	790	772	753	781	777	757	**	$P < 0.10$	NS
17 wk body wt (g)	1 808	1 763	1 793	1 757	1 786	1 775	1 800	1 760			NS
Age at 1st egg (d)	152.2	157.0	138.2	143.2	154.6	140.7	145.2	150.1	***	**	NS
Egg number (till age 54 wk)	167.6	180.4	192.2	193.9	174.0	193.0	179.9	187.2	***		NS
Hen-day laying rate (%)	74.2	81.7	80.1	82.4	78.0	81.2	77.2	82.1	$P < 0.10$	**	NS
Mean clutch length (d)	5.0	6.0	5.6	6.7	5.5	6.2	5.3	6.3	*	**	NS
Pause days (%)	12.3	5.0	7.3	6.5	8.7	6.9	9.8	5.7		*	NS
Shell-less eggs (%)	1.3	0.9	2.0	1.8	1.1	1.9	1.7	1.4	**		NS
Double yolked eggs (%)	0.9	0.4	1.8	1.3	0.7	1.5	1.4	0.9	***	*	NS
Cracked eggs (%)	9.5	12.5	8.1	10.1	11.0	9.1	8.8	11.3			NS
Mean egg wt (g)	55.7	53.9	54.5	52.2	54.8	53.3	55.1	53.0	**	***	NS
Variables concerning feed efficiency											
W = mean body wt (g)	2 459	2 357	2 351	2 318	2 408	2 334	2 405	2 337			NS
ΔW = body wt variation (g/28 d)	78.0	77.0	44.7	67.3	77.5	56.0	61.3	72.2	*		$P < 0.10$
E = egg mass (g/28 d)	1 220	1 294	1 297	1 280	1 257	1 289	1 259	1 288			NS
O = feed intake (g/28 d)	3 540	3 595	3 495	3 501	3 568	3 498	3 517	3 548			NS
R = residual feed intake (g/28d)	−43.2	+37.3	−6.4	+13.1	−12.9	+3.4	−24.8	+25.2			NS
O/E = feed efficiency	2.90	2.78	2.70	2.73	2.84	2.71	2.79	2.76			NS

$*P < 0.05$; $**P < 0.01$; $***P < 0.001$; NS : not significant

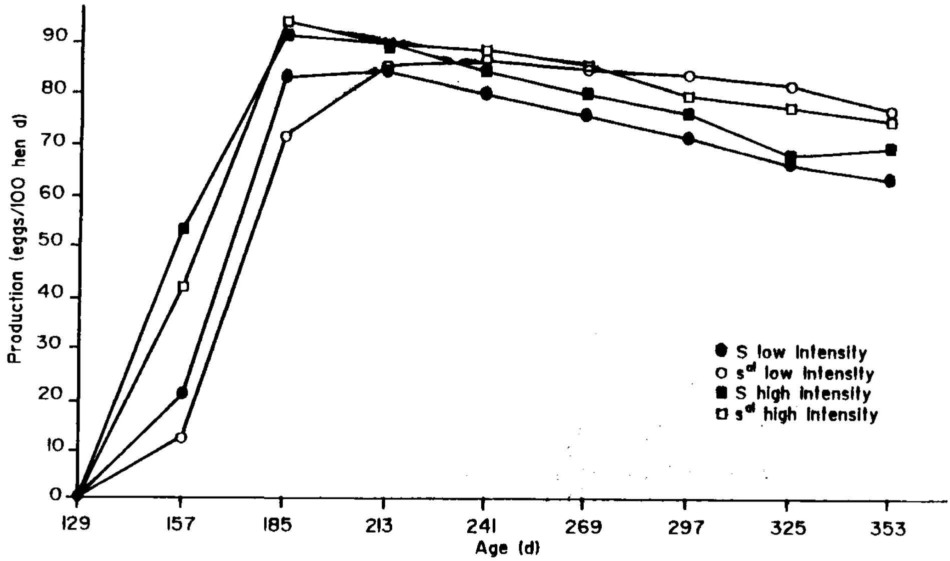

Fig 1. Laying curve to 353 d of age for the 4 groups (mean hen-day production for successive 28-d periods).

of age were respectively 7/47 and 3/48 for colored and albino females at high light intensity, and 2/49 and 4/47 for the colored and albino females at low light intensity.

Effects associated with the s^{a1} gene

Pooling the 2 treatments, the albino gene was associated with a slight depressing effect on 8-week body weight ($P < 0.10$); a similar effect was not significant at later ages. The s^{a1} layers showed on average a 5-day retardation of the age at first egg, and 5% higher hen-day laying percentage than S females, with average clutches longer by 1 day and fewer pause days. As a consequence the number of eggs from s^{a1} layers was superior (+7.3), but on the whole this effect was not significant. The mean egg weight was 2.1 g lower for the albino than for the colored hens.

A slight reduction of body weight and mean egg weight was found associated with the s^{a1} gene by Mérat *et al* (1986) and Silversides and Crawford (1990a, b). A delay for the sexual maturity of albino females, comparable to that found in the present work, was mentioned by Mérat *et al* (1986) and Silversides and Crawford (1990b). Mérat and Bordas (1989) did not find this relationship, not did they find a genotype effect on egg weight. On the other hand, the present results agree with those of Mérat and Bordas (1989) concerning the absence of any effect associated with the s^{a1} allele on eggshell strength and feed efficiency. However, in both studies the percentage of cracked eggs was slightly higher for albino hens. In both studies also, the body weight gain of adult hens in a 28-d period was slightly superior for albino females, possibly as a late compensation for the small initial growth retardation.

In interpreting the differences concerning egg production traits, it is interesting to compare the present results with those of Mérat and Bordas (1989), in spite of the absence of statistically significant genotype × treatment interactions shown in table I. From this table it is seen that for hen-day laying percentage and mean clutch length, the advantage of the s^{a1} over the S hens is 7.5% and 1 day respectively, the percentage of pause days of the former is 7.3% less, and they lay 12.8 eggs more in the environment characterized by low light intensity in the brooding-rearing house. A t-test between the mean of the albino and that of colored hens within this environment is significant at the 1% and 5% level for hen-day laying rate and egg number respectively. This lighting treatment was the same (low light intensity before 17 weeks, high intensity afterwards) as the one called "high intensity group" in the report by Mérat and Bordas (1989). Mérat and Bordas (1989) found that the superiority of the albino hens over the colored ones was 9.4% for hen-day laying rate, 2.7 days for mean clutch length, and 19.1 eggs. These differences seem reasonably similar in the 2 experiments. In the present work, the same differences, although being in the same direction, are numerically less in the group receiving the higher light intensity in the rearing period: 2.3% for hen-day percent production and only 1.7 more eggs produced by the s^{a1} hens.

Effect of light intensity

Irrespective of the genotype, the lighting intensity received until the age of 17 weeks has several highly significant effects. The brighter light increases the 8-week weight by about 30 g, it hastens by 14 days the mean age at first egg, and seems to slightly increase (+3.2%) the hen-day laying rate, so that 19 more eggs are obtained with this treatment. Other effects, generally associated with an earlier sexual maturity, are a lower average egg weight (−1.5 g), an increased percentage of shell-less and double-yolked eggs, and a reduced body weight gain of adult hens. The adult body weight shows a non-significant 100 g reduction, and feed efficiency and percent cracked eggs are not affected. In total, the more intense light at the juvenile stage is superior for egg production, with a slight advantage of the s^{a1} genotype suggested in this environment.

The stimulating effect on sexual maturity, found here to be associated with a high light intensity given to young chicks, was not found in earlier works. Sauveur (1988) mentions that the range of 1 to 5 lux applied during the growing period has no effect on laying. Skoglund *et al* (1975), with intensities of 5 to more than 50 lux and Morris *et al* (1988), with mean intensities of 2 and 10 lux observed no advantage for egg production associated with brighter light, but their treatments mainly concerned the egg laying period. Brake (1988, 1989) compared the effect of 8 h light provided by incandescent bulbs (20 lux) or daylight (800 lux) on subsequent egg production, the former group showed an advantage or not depending on the season.

The apparent discrepancy between our results and those of others may be due to the fact that we gave 10 h lighting per day in the brooding–rearing house instead of the 8 h more usually provided, so that with this longer daily illumination the light intensity may have become more stimulating. Among other possible differences is the wider range of our light intensities in comparison with the usually low values recommended for practical purposes (North, 1984). Anyway our aim was not to study the effects of light *per se*, but to investigate the specific response of albino birds to this environmental factor, including a comparison with a former experiment which conditioned the choice of lighting treatments.

In conclusion, this work agrees with a previous study (Mérat and Bordas, 1989) as regards an advantage of albino hens for egg production traits when they are given dim light as juveniles and bright light during the egg production period. This advantage is lowered if the light intensity during the growth period is higher. On the other hand, owing to stimulation of sexual maturity by a more intense light up to 17 weeks of age, irrespective of the genotype at the S locus, under our conditions the subgroup which showed the best laying performance was represented by the albino hens receiving a high light intensity both before and after the age 17 weeks.

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