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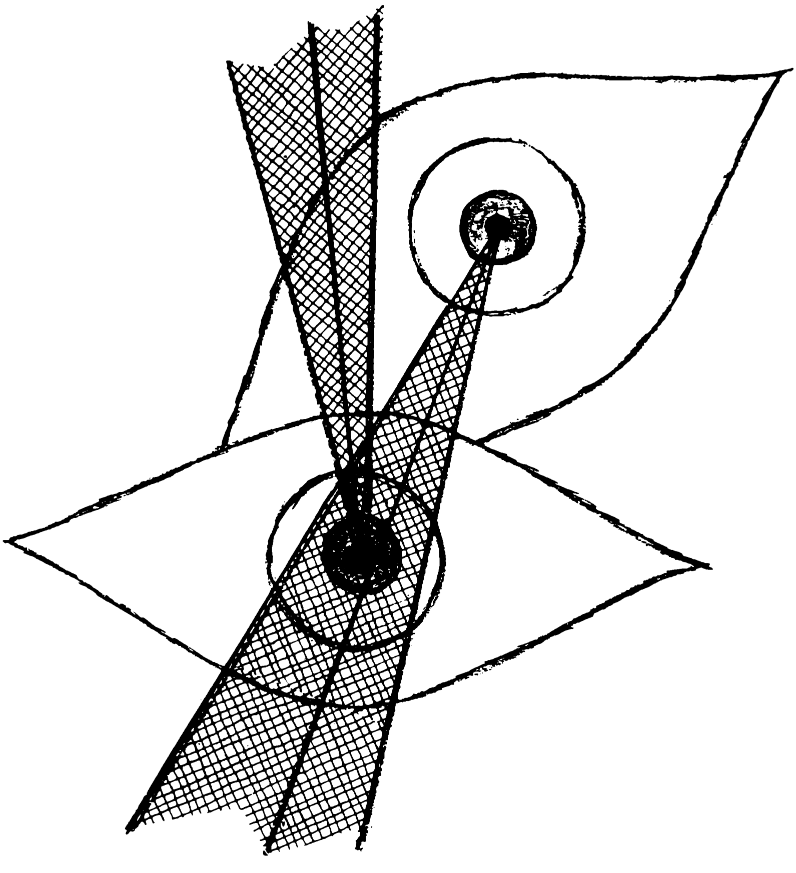

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THE INFLUENCE OF TWO LIGHT MANAGEMENT SYSTEMS ON THE GROWTH AND PRODUCTION OF COMMERCIAL LAYERS

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Light is important in the regulation of reproduction in higher animals. Ovarian activity in birds is stimulated when there is exposure to increased periods of light (Warren and Scott, 1935; Kendeigh, 1941). This activity is the result of nervous stimulation of the anterior pituitary and the consequent secretion of gonad stimulating hormones (Benoit, 1935). Thus supplementation of natural light with artificial light tends to increase egg production during periods of short natural light although annual egg production may not necessarily be increased (Tomhave and Mumford, 1927; Kable, *et al.*, 1928; Callenbach, *et al.*, 1943).

The data presented by Byerly and Knox (1946) clearly indicates the importance of day length on age at sexual maturity. Morris and Fox (1960) have hypothesized that the rate of maturation of a bird is directly proportional to the rate of change in day length, and that maturation age is not influenced by the absolute amount of light available at any stage during the development period. By contrast, King (1961) observed that the more hours of light received by pullets during the growing season the earlier they matured sexually. King (1959) has also reported that pullets raised under day lengths restricted to 6 hours, and then given 15 minutes or 3% weekly increments in photoperiod length from sexual maturity throughout the laying year, laid more eggs for the year than those grown and maintained on a constant 14-hour day.

The experiment described here was conducted to determine the effect of 2 increasing light schemes on various growth and production characteristics of 2 commercial egg laying strains.

EXPERIMENTAL PROCEDURE

On July 28, 1959, 504 day-old pullets were started in 4 mechanically ventilated, light-proofed, brooder pens. Sixty-three birds of a commercial double cross hybrid (Strain A) and 63 of a strain cross (Strain B) were intermingled in each pen. Two of the pens were

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maintained on 6 hours of light and the other 2 on 14 hours throughout the brooding period. When 8 weeks of age, the pullets were moved to 4 light-proofed, mechanically ventilated laying pens with the 6 to 14 hour light ratio maintained as before.

At 20 weeks of age, the groups which had received 6 hours of light per day were given 3% weekly increments of photoperiod length according to the schedule suggested by King (1959). Those receiving 14 hours of light during the growing period were continued on this regime until the 30th week of egg production (50 weeks of age) at which time the 6 hour-3% increment groups had reached 14 hours of daily light (see Figure 1). All groups were then continued concurrently on a 3% increment program until termination of the experiment on December 13, 1960, when the birds were 72 weeks of age. Management factors, other than light schedules, during the brooding, rearing, and laying periods, were essentially the same for all groups.

Light intensities at bird level, measured with a Weston light meter, were 2 to 3 ft. candles in the brooding pens and 1 to 2 ft. candles in the laying pens, depending on position in relation to the centrally located, overhead, incandescent lamp.

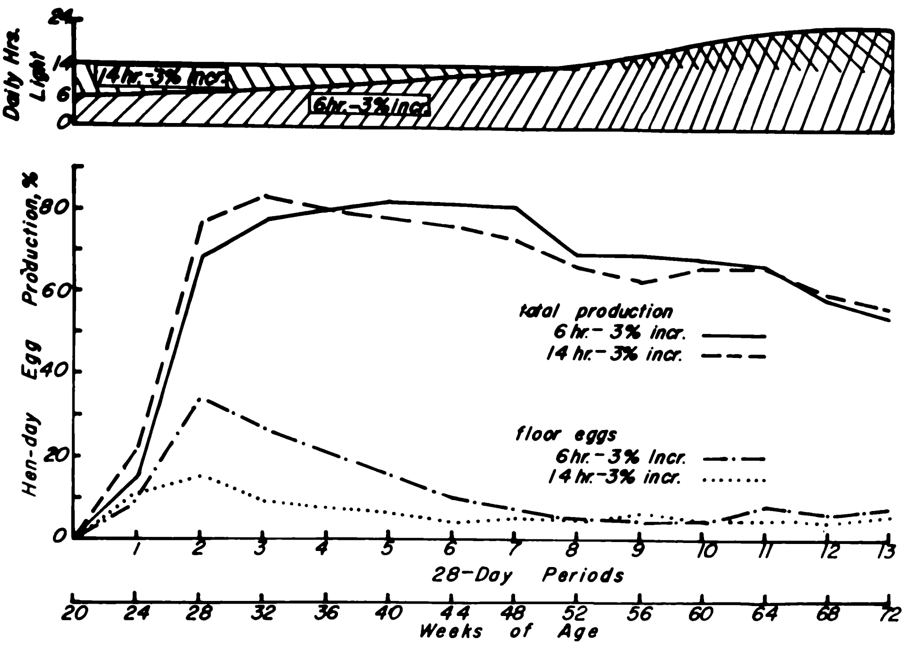

Figure 1.—Annual hen-day egg production.

Until 8 weeks of age the birds were provided, *ad libitum,* a starter ration containing 20% crude protein and approximately 880 calories of productive energy per pound. After 8 weeks, the grower and layer rations contained 16% crude protein and approximately 850 calories of productive energy per pound.

Individual body weights were obtained at 8, 20, 50, and 72 weeks of age. Feed consumption by pens was recorded throughout the experiment. Daily trap-nesting was practiced and egg production data were averaged by 28-day periods. Egg weights were measured at 26 and 54 weeks by taking the average weight of 3 consecutive eggs per bird laying over a 10-day period. Data were statistically treated by analysis of variance to determine differences between light treatments, strains, replicates, and the significance of their interactions. Percentages were subjected to arc-sin transformations before analysis.

RESULTS AND DISCUSSION

Eight Week Body Weight and Feed Conversion.

As shown in Table 1, Strain B was significantly heavier than Strain A at 8 weeks of age, and both strains were significantly heavier at this age when day length was restricted to 6 hours per day. Because there was no significant difference between replicates, these were combined. It was evident that both strains responded similarly to the light restriction and thus a significant treatment x strain interaction was not observed. Feed consumption and conversion could only be measured on a pen basis, because strains were intermingled. Although little difference was noted in feed consumption per bird up to 8 weeks of age, feed was more efficiently converted by the birds receiving a 6-hour day.

Table 1.—8 and 20 Week Weights and Feed Conversion.

		8 weeks		20 weeks	
Light, per day	Strain	Weight** ± S. D.	Unit feed* per gain	Weight** ± S. D.	Unit feed* per gain
hrs.		*gm.*		*gm.*	
6	A	638 ± 42	2.99	1297 ± 166	7.83
	B	685 ± 57		1394 ± 140	
14	A	622 ± 56	3.20	1396 ± 124	7.26
	B	660 ± 50		1522 ± 139	

**Differences between treatments and strains highly significant ($P \leq 0.01$).
*Differences between treatments significant ($P \leq 0.05$).

These results agree essentially with those presented by Moore (1959) who found that although broiler growth at 3 to 4 weeks of age was most rapid under continuous light, less light was required as the birds approached 8 weeks. Lamoreux (1943) also observed that 7- to 9-month old White Leghorn males made significantly greater gains in body weight when light was restricted to less than 9 hours per day.

Twenty Week Body Weight and 8 to 20 Week Feed Conversions.

At 20 weeks of age, Strain B was again significantly heavier than Strain A, but the effect of light was apparently reversed; those groups receiving 14 hours of light per day were significantly heavier (Table 1). This was also reflected in feed conversion. It should be noted however, that these data were confounded with the onset of sexual maturity and the consequent added weight of matured sexual organs. Shutze, *et al.* (1960) observed that pullets grown on continuous light were 0.1 to 0.4 pounds heavier at 21 weeks of age than birds grown under shorter light periods.

Age at Sexual Maturity

In Table 2 are shown the mean ages at first egg and at 50% egg production for both strains and light treatments. Both strains matured at approximately the same age, but those restricted to 6 hours of light during the growing period were, on the average, 11 days later at first egg and approximately 9 days later at 50% production. These differences were significant ($P \leqq 0.01$).

These data agree with those of King (1961) but are in contrast with the hypothesis of Morris and Fox (1960) that the absolute amount of light available during the growing period has little influence on sexual maturity. Bieller (1960) reported that pullets restricted to

Table 2.—Age at 1st Egg and at 50% Production.

		Age ± S. D. at:	
Light, per day	Strain	1st** egg	50%** production
hrs.		*Days*	*Days*
6	A	183 ± 39	196 ± 39
	B	185 ± 31	198 ± 34
14	A	176 ± 27	186 ± 33
	B	170 ± 32	191 ± 60

**Differences between treatments highly significant ($P \leqq 0.01$).

6 hours of daily light were retarded in age at sexual maturity; however, his comparison was to February hatched pullets which had the added stimulus of increasing light.

Significant treatment x strain interactions were not observed in this experiment for these 2 criteria of sexual maturity, age at first egg and at 50% production, confirming the conclusion of McClary (1960) that genetic x environment interactions may not be important for this parameter.

Annual Hen-Day Egg Production

The pattern of hen-day egg production throughout the production year, by 28-day periods, is shown in Figure 1. The two lighting schemes imposed on the groups are graphically depicted at the top.

When light was limited, the 6 hour-3% increment groups laid, at a maximum, more than 30% of the eggs out of the nests. This gradually declined as photoperiod length increased. Observations made by entering the pens immediately after the lights went on indicated that a large number of these were laid on the floor or roost during the dark period. Palpation indicated that the numbers of birds not utilizing the nests at all were approximately the same in both treatment groups; however, the frequency of out-of-nest eggs by birds with trap nest records was higher. Analysis of egg production by strains would thus be unrealistic and therefore these were combined.

No significant difference between light treatments was found (Table 3); however, the highly significant treatment x period inter-

Table 3.—Analysis of Variance of 52 Week Hen-day Egg Production and Feed Conversion by 28-Day Periods.

Source of Variation	Df	Mean Squares: Percent Egg[2] Production	Mean Squares: Feed per Doz. Eggs
Total	51		
Replicates	1	1.81	.36
Light Treatments	1	.72	.61*
28-Day Periods	12	488.94**	27.61**
Interactions			
R x T	1	2.16	.25
R x P	12	2.75	.03
T x P	12	12.91**	1.16**
R x T x P	12	2.37	.12

[2]Arc-sin transformation.
*$P \leq 0.05$.
**$P \leq 0.01$.

action indicates that the relationship between treatments was not the same throughout the laying year. Figure 1 shows that the 14 hour-3% increment groups produced at a higher rate for the first 4 periods; during the next 6 periods the 6 hour-3% groups produced at a higher rate; and for the last 2 periods the 14 hour-3% groups again laid at a higher rate. It will be noted that the 14 hour-3% groups began to receive light increments at the beginning of the 8th period and that by the 9th period this stimulus was reflected in an upturn in production rate. The overall hen-day percentages are shown in Table 4.

Table 4.—Summary of Annual Hen-Day Egg Production and Feed Efficiency.

Light Schedule	Egg Production	Feed Per* Dozen Eggs
	%	*lb.*
6 hour—3% increment	67.30	4.76
14 hour—3% increment	67.63	5.06

*Differences between treatments significant ($P \leq 0.05$).

These results confirm those of King (1959) in that succeeding increments of daily light during the laying year stimulated egg production. However, the maintenance of a 14-hour day throughout the growing period and up to the 32nd week of egg production before beginning the increment, resulted in approximately the same annual egg production as growing the birds on 6 hours of light and beginning the light increment at point of lay. Furthermore, the high incidence of out-of-nest eggs during periods of short daily light could make a 6 hour-3% increment system impractical for floor managed flocks.

Feed Per Dozen Eggs

Pounds of feed per dozen eggs was calculated by pens by 28-day periods. The analysis shown in Table 3 indicates that there was a significant difference between treatments ($P \leq 0.05$), periods ($P \leq 0.01$), and a significant treatment x period interaction ($P \leq 0.01$). It may be seen in Figure 2, that except for the first period, the 6 hour-3% increment groups produced more eggs per pound of feed throughout the experimental year than the 14 hour-3% groups. The significant interaction was the result of the reversal after the first period.

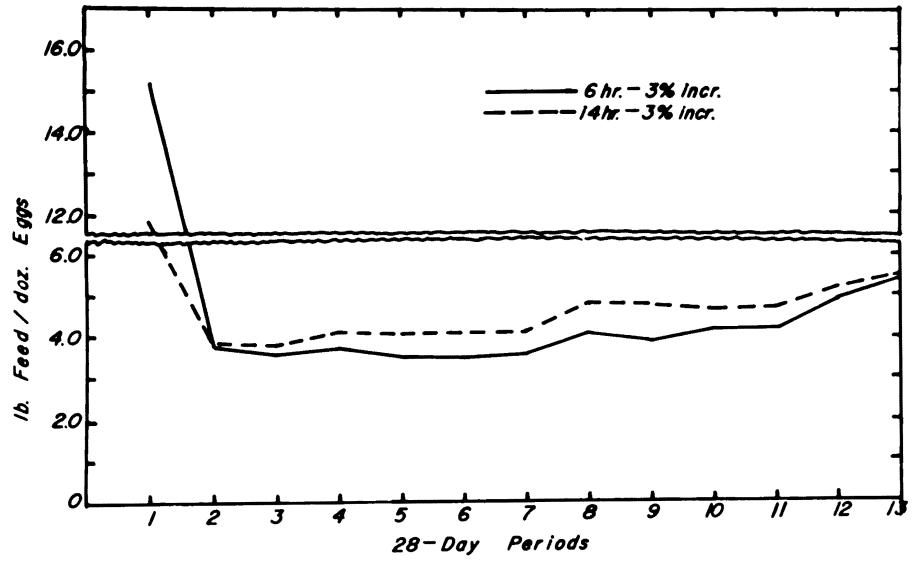

Figure 2.—Pounds of feed per dozen eggs.

Body Weight

Table 5 indicates that Strain B was heavier than Strain A at 50 and 72 weeks of age. Further, the 14 hour-3% increment groups were significantly heavier at both ages measured. This explains, in part, the more efficient feed utilization obtained by the 6 hour-3% groups in spite of the similar annual egg production. It is of interest to note that the lower body weight resulting from the shorter photoperiod was extended even after both treatment groups were on an increasing light schedule.

Table 5.—50 and 72 Week Body Weights.

Light Schedule	Strain	Age	
		50 weeks**	72 weeks**
		gms. ± S. D.	gms. ± S. D.
6 hour—3%.........	A	1645 ± 138	1696 ± 173
	B	1837 ± 230	1832 ± 238
14 hour—3%.........................	A	1803 ± 173	1911 ± 280
	B	2095 ± 277	2185 ± 319

**Differences between light treatments and strains highly significant ($P \leqq 0.01$).

Egg Weight

The effects of light treatment and strain on egg weights are shown in Table 6. Birds on the 14 hour-3% increment schedule laid significantly heavier eggs at both ages measured. The differences between strains were 2.5 and 1.8 grams at 26 and 54 weeks respectively for the 6 hour-3% groups, but only 0.9 and 0.6 at the same ages for the 14 hour-3% groups. This resulted in significant treatments x strains interactions at both ages. It would appear from these results that Strain B required less light to approach maximum egg size than did Strain A, and thus the longer daily photoperiod had more effect on this measurement in Strain A than it did in Strain B.

Table 6.—Egg Weight.

Light Schedule	Strain	Age: 26 weeks**	Age: 54 weeks**
		gms. ± S. D.	gms. ± S. D.
6 hour—3%	A	50.3 ± 2.6	57.7 ± 3.7
	B	52.8 ± 3.3	59.5 ± 3.9
Difference	B-A	2.5	1.8
14 hour—3%	A	51.7 ± 3.3	61.3 ± 4.3
	B	52.6 ± 3.1	61.9 ± 3.1
Difference	B-A	0.9	0.6

**Differences between light treatments highly significant ($P \leq 0.01$).

SUMMARY AND CONCLUSIONS

The effects of 2 increasing light schemes on the growth and production of commercial layers were evaluated. Because this represents a single generation study, conclusions must necessarily be tempered. The experiment is presently being repeated with slight modification. In general, the results suggest the following:

1. At 8 weeks of age, pullets of these egg producing strains were heavier and converted feed more efficiently when grown under 6 hours of daily light as compared to those grown under 14 hours of light.

2. Sexual maturity as measured by age at first egg and 50% production was significantly delayed by restricting growing pullets to 6 hours of daily light.

3. Birds grown on 6 hours of daily light and then given 3% weekly increments of light weighed less at maturity and during the laying year than those grown under 14 hours of light and given 3% weekly increments.

4. No significant difference in annual hen-day egg production between the 6 hour-3% increment and 14 hour-3% increment groups was noted, although the relationships between treatments varied during the year.

5. Birds on the 6 hour-3% schedule produced eggs on significantly less feed than those on the 14 hour-3% schedule.

6. Egg weights, measured at 26 and 54 weeks of age, were significantly lower in the 6 hour-3% groups, and it was observed that the limitation of light restricted the egg weight of one strain more than the other.

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