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Original Article

Lighting Programs of White Layers Hens in Start Phase Production

■Author(s)

Souza C[I] https://orcid.org/0000-0003-0858-5237
Bedin AFS[I] https://orcid.org/0000-0002-1747-2819
Gewehr CE[I] https://orcid.org/0000-0002-1590-0242

[I] Universidade do Estado de Santa Catarina - UDESC.

■Mail Address

Corresponding author e-mail address
Clóvis Eliseu Gewehr
Rua Luis de Camões, 2090. Bairro Conta Dinheiro, Lages – SC. CEP 8850-000, Brasil.
Phone: +5549 999633624
Email: clovis.gewehr@udesc.br

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ABSTRACT

This research aimed to study the effect of light regime on performance and egg quality of white laying hens applied at the start laying phase. A total of 420 Hy line White laying hens, at 19 weeks of age were used, distributed in a completely randomized design, during 5 periods of 28 days, extending from January to June, corresponding to the age of 19 to 38 weeks of age of the birds. Three lighting programs were evaluated: continuous 16 h of light and 8 h of dark (CONT); intermittent program with two 2-min photophases equidistant at 16 h between natural light and 8 h of dark (INT) and continuous program only using decreasing natural light (LND). Feed intake (g/bird/day), egg production (%bird/day), egg weight (g), egg mass (g/bird/day), feed conversion (g/g) and egg density (g/cm^3) were evaluated. Feed intake and feed conversion were higher (p<0.05) in birds submitted to the CONT program compared to the LND program, however the CONT and LND programs did not differ (p>0.05) from the INT. Egg production, egg weight, egg mass and egg density were similar (p>0.05) between programs. Intermittent program with two photophases of 2 min equidistant 16 h between natural light can be applied in light layers at the start laying phase without impairing the productive performance and eggshell quality.

INTRODUCTION

Lighting is an essential component of successful commercial poultry production. For laying birds (including breeders) light is important to the development and functioning of the bird's reproductive system, determining the starts of laying phase and egg production (Patel et al, 2016).

Lighting programs are used in laying hens to optimize egg production (Nunes *et al.*, 2017), and there are different indications of programs that can be used in commercial creations, depending on the type of shed in which the birds are raised and the creation phase (Gewehr & Freitas, 2007).

Modern laying hen lines have been suffering intense selection pressure to improve production rates, being genetically predisposed to maximum egg production. In this context, they may be refractory to changes in light regime, and it is possible that current hens are more tolerant to lower light intensities (Charles & Tucker, 1993; Sauveur, 1996).

Intermittent programs applied to birds reared in open sheds show positive and promising results (Freitas *et al.*, 2010; Gewehr *et al.*, 2012). It is an interesting tool that can be used in the management of commercial laying hens raised in sheds that make use of natural light (Gewehr & Freitas, 2007). Intermittent lighting programs make it possible to reduce electricity consumption in open sheds without affecting zootechnical performance and egg quality (Gewehr *et al.*, 2007; Yuri *et al.*, 2016). Intermittent programs alternate cycles of light and dark in a photostimulatory period of 15 to 16 h of light/day, followed by eight to nine continuous hours of darkness (Freitas *et al.*, 2010). These programs should be applied only after the birds are already adapted and trained to continuous programs (Gewehr & Freitas, 2007). Intermittent lighting programs are effective for laying hens maintained in open-sided houses, which are typically used in Brazil for commercial egg production, this lighting programs provide better cost-benefit ratio (Jácome *et al.*, 2014).

Due to the intense genetic improvement that birds undergo, the age to photostimulate modern laying hens must be periodically reassessed to optimize production (Ernst *et al.*, 1987). In this context, it should be noted that the natural photoperiod in the southern hemisphere, at the summer solstice, is around 14 h, sufficient exposure time to stimulate the reproductive system of a layer (Etches, 1996). Researches that aim minimizing the use of energy, without affecting the productivity of the birds are necessary for the success of laying poultry (Nunes *et al.*, 2017), as well as a recent research revealed that a natural lighting program had beneficial effects on domestic birds (Wichman *et al.* 2021).

The hypothesis of this research is that intermittent lighting can be used at the beginning of the laying period and that modern birds do not need to be photostimulated.

This research aims to evaluate the productive performance and eggshell quality of white laying hens submitted to continuous lighting programs of 16 h, intermittent programs with two photophases of 2 min equidistant at 16 h between natural light and a continuous program only with decreasing natural light applied to the beginning of the laying phase.

MATERIAL AND METHODS

An experiment lasting 140 days, divided into five periods of 28 days, extending from January to June, was carried out in the Poultry Sector of the Department of Animal Production and Food of the Agroveterinary Sciences Center of UDESC - Lages/SC, located at the geographic coordinates 27°48’11.9”S and 50°18’17.9”W.

A total of 420 Hy line white laying hens, aged 19 weeks, were raised in a masonry shed, with anti-bird screen and translucent plastic sheets on the sides, with the birds reared on shavings bedding and distributed in a completely randomized design with 10 repetitions of 14 birds, in 30 boxes of 2 m². Each box was equipped with a tube feeder and a pendulum drinker and three nests with dimensions of 30 x 30 x 40 cm (front x bottom x height).

Up to 19 weeks of age, the birds received feed and water *ad libitum*, raised in an open shed, this growth phase coinciding with a period of increasing natural photoperiod, requiring the use of artificial lighting to submit the birds to a continuous lighting program of 14 hours of light and 10 h of dark.

The hens were submitted to three lighting programs (treatments): continuous for 16 h, intermittent and continuous with only natural light decrease. The continuous program of 16 hours of light/day (CONT) is recommended by the manual of the lineage used, where the lights in the shed were turned on at 4:00 am and turned off at dawn; lit again at 5:30 pm and turned off at 8 pm, so that the birds received a continuous photoperiod (artificial + natural light) of 16 h and a scotoperiod (night) of 8 h. The intermittent program (INT) had the lamps on at 4 am and off after 2 min (photophase 1), followed by a dark period (scotophase 1) until dawn and after the sequence with natural daylight (photophase 2) until dusk, when there was again a dark period (scotophase 2) and the lamps were turned on again at 7:58 pm and turned off at 8:00 pm (photophase 2). This program was composed of three photophases and two scotophases in 16 h, and the scotophases increased due to the shortening of the natural photoperiod during the experimental period. In the continuous program with only decreasing natural light (LND), the birds received only the natural photoperiod. In this program, at the beginning of the experimental period the birds were submitted to 12:56 h of natural light and at the end 10:07 h, because between the summer solstice and the winter solstice, the time in hours of natural light during the day decrease in the southern hemisphere.

The experimental shed was adapted, being divided into tree environments using non-translucent plastic tarps, preventing the passage of light from one environment to another. Each environment had two LED lamps of 15 watts, and the brightness of the environments was measured with a luxmeter, in order to guarantee that at points equidistant from the lamps there was no luminous intensity of less than 15 lux. There was no interference from light outside the shed that could interfere with the treatments.

The ration (Table 1) was formulated as recommended by Rostagno *et al.* (2017), being provided *ad libitum* along with water. The submission of the birds to the respective lighting programs began at 19 weeks of age, when they had already reached an average index of 5% of posture.

Table 1 – Composition of experimental diets for laying hens from 19 to 38 weeks of age.

Ingredients	Amount - (kg)
Corn	62.08
Soybean meal	24.41
Limestone	8.50
Dicalcium phosphate	1.14
Vegetable oil	2.85
Salt	0.49
Methionine	0.13
Mineral/vitamin premix[1]	0.40
Total	100.0
Calculated composition	
Metabolizable energy kcal/kg	2900
Crude protein %	16.02
Calcium %	3.66
Phosphorus disponible %	0.341
Sodium %	0.219
Methionine digestible %	0.380
Lysine digestible %	0.751

[1] Supplied per kilogram in the total diet: vitamine A – 2,333 UI/kg; vitamine D3 – 6,666 UI/kg, vitamine E – 1,667mg/kg, vitamine K3 – 5,00 mg/kg; vitamine B2 – 1,00 mg/kg, vitamine B12 – 2,667 mg/kg, Niacina – 6.666.670 mg, choline – 78.1 mg/kg, pantothenic acid – 12 mg/kg, copper 266 mg/kg, iron 16 mg/kg, manganese 20 mg/kg, zinc – 16.6 mg/kg, iodo – 400 mg/kg, selenium 0.66 mg/kk, zinc bacitracine – 6.66 mg/kg.

The performance of hens was evaluated through feed intake (g/bird/day); egg production (% eggs/bird/day), with eggs collected twice a day, at 10:00 am and 4:30 pm; weight of eggs (g) weighed on a digital scale with a precision of 0.001g, where all intact eggs from the last two days of each experimental period were evaluated, obtaining the average weight; egg mass (g/bird/day) obtained through the product between the percentage of production and the average weight of eggs; feed conversion (g/g) obtained in each 28-day period by dividing the average feed intake (g) by the average egg weight (g). Egg quality was measured by weight, as previously described (g) and egg gravity (g/cm^3), whose methodology is indicated to assess shell quality. To determine gravity, the same eggs were used to obtain weight, which were immersed in a NaCl solution with densities ranging from 1070 to 1100 g/cm^3, with a gradient of 5 g/cm^3 between them, determined with the aid of a densimeter.

The results of the global averages and of each period of 28 days were submitted to analysis of variance and the differences analyzed by the Tukey test (5%), using the PROC GLM procedure of the computational software SAS® University Edition (2016). For the global averages, the periods were considered as a measure repeated over time.

RESULTS

Feed intake and feed conversion of birds aged 19 to 38 weeks were influenced ($p<0.05$) by the light programs (Table 2), being higher for laying hens submitted to the CONT program in relation to those that received LND, however between CONT and INT programs and between INT and LND, no difference ($p>0.05$) was observed in consumption and conversion. Egg production and egg mass did not differ between the evaluated programs. Regarding egg quality, there was no difference ($p>0.05$) for weight and severity of eggs from 19 to 38 weeks between programs.

Table 2 – Performance of laying hens submitted to different lighting programs* from 19 to 38 weeks of age.

	Lighting programs			CV (%)	SEM	Valor de *p*
	CONT	INT	LND			
Feed intake g/bird/day	108 a	103 ab	100 b	11.5	5.78	$p<0.0001$
Egg production %/bird/day	84.7	84.6	81.7	9.63	5.86	NS
Egg weight g	58.4	57.9	57.1	6.3	1.70	NS
Egg mass g	49.7	49.2	46.7	13.5	3.69	NS
Density g/cm^3	1086	1088	1089	0.76	7.40	NS
Feed conversion kg/kg	1.84 a	1.77 ab	1.75 b	7.84	4.72	$p<0.0001$

*Lighting programs: CON (continuous), INT (intermittent) and LND (decreasing natural light)

Means with unequal letters on the lines differ statistically by tukey test (5%).

When analyzing the effect of light programs in each period on feed intake (Figure 1), it is observed that in the third (between 27 and 30 weeks), fourth (between 31 and 34 weeks) and fifth (35 and 38 weeks) periods, hens submitted to the CONT consumed more ($p<0.05$) food in relation to the other programs. In the first (19 to 22 weeks) and second (23 to 26 weeks) periods, no difference was observed ($p>0.05$). For egg production (Figure 2) and egg mass (Figure 3), hens submitted to

CONT and INT treatments showed higher (p<0.05) egg production in the last two evaluation periods compared to hens submitted to LND, and for the other cycles no program effects were observed (p>0.05).

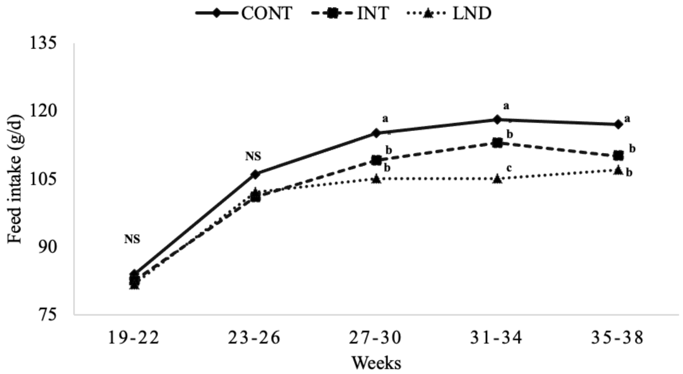

Figure 1 – Feed intake (g) of laying hens submitted to continuous (cont), intermittent (INT) and decreasing natural light (LND) lighting programs.

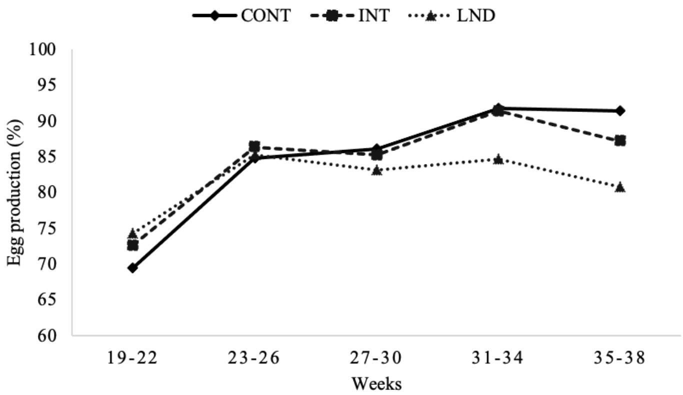

Figure 2 – Egg production (%) of laying hens submitted to continuous (cont), intermittent (INT) and decreasing natural light (LND) lighting programs.

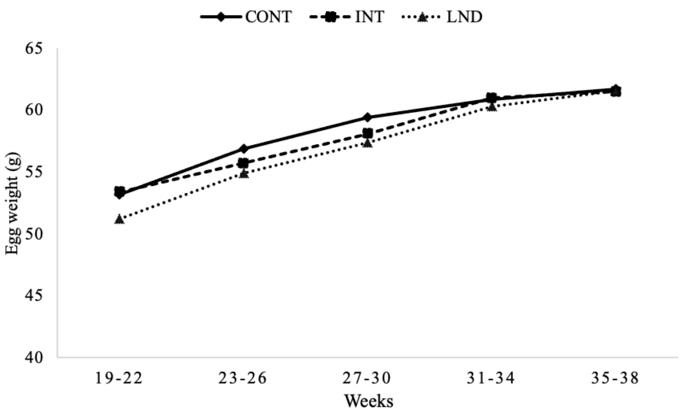

Figure 3 – Egg weight (g) of laying hens submitted to continuous (cont), intermittent (INT) and decreasing natural light (LND) lighting programs.

In the evaluation of egg weight (Figure 4), the hens submitted to the CONT photoperiod presented greater (p<0.05) weight in the first, second and third period in relation to the birds submitted to the LND program. However, only in the first cycle of evaluation, the INT program showed higher egg weight (p<0.05) than the LND program, and this difference was not observed in the other cycles.

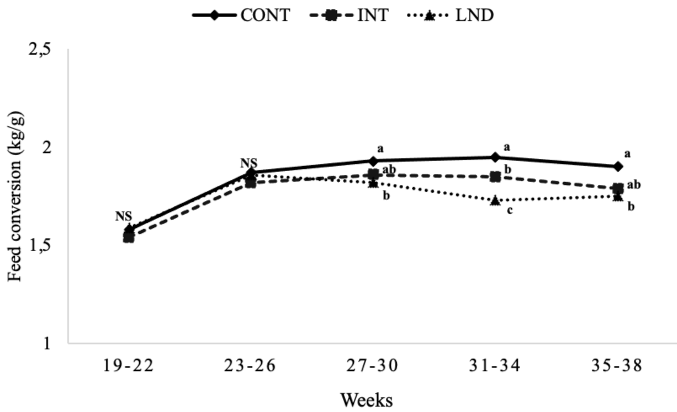

Figure 4 – Feed conversion (g/g) of laying hens submitted to continuous (cont), intermittent (INT) and decreasing natural light (LND) lighting programs.

Laying hens submitted to the CONT program have higher (p<0.05) feed conversion (Figure 5) than those submitted to LND in the last three egg laying cycles evaluated, however birds in the program only differ statistically (p<0.05) from the INT in the fourth laying cycle. In the first and second laying periods, no difference (p>0.05) was observed in feed conversion.

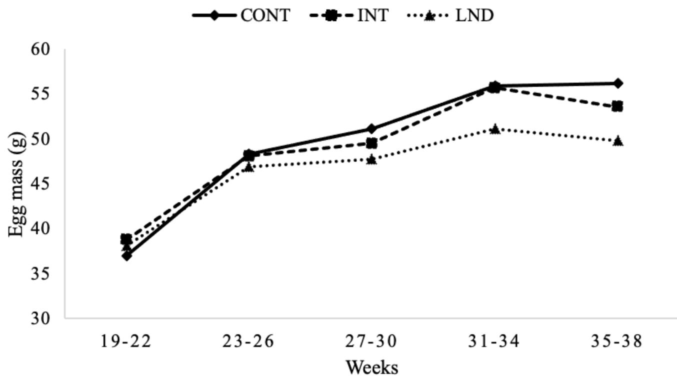

Figure 5 – Egg mass (g) of laying hens submitted to continuous (cont), intermittent (INT) and decreasing natural light (LND) lighting programs.

DISCUSSION

The reduction in the feed intake in the birds submitted to intermittent programs compared to continuous programs is highlighted in other works (Freitas *et al.*, 2005; Koelkebeck & Biellier, 1986), attributing the fact to the decrease in primary activities (locomotion, movements) by birds (Coenen *et al.*, 1988). However, this effect was not observed for the INT treatment in relation to the CONT program during the entire experimental period (19 to 38 weeks). The decrease in the feed intake of hens in the INT and LND programs in relation to those submitted to the CONT in the last three periods is justified due to the progressive reduction of the natural photoperiod in these three cycles. This reduction in the photoperiod increased the scotophases for the INT treatment and the scotoperiod for LND. Thus, the longer period of darkness is probably the factor that causes the reduction in feed intake to occur. Xin *et al.* (2021) observed that laying hens raised in a light regime of 16 hours of light and 8 hours of dark, presented lower feed intake than birds in a regime of 9 hours of light and 15 hours of dark.

It was observed in the production and egg mass that the laying hens submitted to the LND program did not maintain the productivity index in the last two evaluation cycles, although there was no difference in the average production from the 19th to the 38th weeks of age. Thus, as the photoperiod decreased (fourth and fifth periods) the hens had a reduction in production and, consequently, in egg mass. This is an indication that modern laying hens still react to stimulation when subjected to long photoperiods, which according to Etches (1996) are considered those with more than 12 h. It is noteworthy that the percentage of reduction in the posture index is not 20 to 40% as written by Cotta (2002), because in the last period, where the natural photoperiod was 10:07 h, the percentage difference observed was 11.59% between CONT and LND programs and 7.34% between INT and LND programs. It is noteworthy that the shortest natural photoperiod in the year for the southern region of the country is 10:06 h (Yuri *et al.* 2016). Probably, the increase in scotophases, without a light stimulus (LND), compromises the release of GnRH, where hens that are exposed to a shorter time of light reduce the release of this hormone, which, in turn, reduces the release of gonadotropins, and consequently, there is no stimulus for follicular growth and maturation compromising egg production (Sharp, 1993). This reduction in the difference between the CONT and LND programs agrees with Charles & Tucker (1993) and Sauveur (1996) who point out that hens have been progressively losing sensitivity to light due to the selection pressure exerted by genetic improvement. This fact justifies the need for periodic studies on lighting programs for laying hens.

The time of 2 min of the photophases of the INT program was enough to stimulate the reproductive system and maintain the egg production and egg mass of the hens when compared to the CONT. This result corroborates the results found by Melo *et al.* (2006), who, testing an intermittent program in quails, indicated viability at the beginning of the laying period, but it is noteworthy that the time of the photophases in this test (initial and final) was 30 min between natural light and equidistant at 17 h. The literature indicates that intermittent programs and the use of natural light only in open sheds provided to birds previously trained to continuous photoperiod, applied from 36 weeks of age, reduce feed intake without affecting egg production (Gewehr *et al.*, 2005; Freitas *et al.*, 2010).

Feed conversion in the last three evaluation cycles was higher in hens that received the CONT program compared to those that received LND program. As the feed conversion is the ratio between feed intake and egg weight, it was observed that it was in the last evaluated cycles that the hens in the CONT program consumed more than those submitted to LND, but the egg weight remained similar. In the INT program, the conversion was similar to the other programs. On the other hand, Sauveur & Mongin (1983); Freitas *et al.* (2005) and Gewehr *et al.* (2012) observed that intermittent programs reduced the conversion in relation to continuous programs, however these works were also carried out with laying hens previously trained to continuous photoperiod and applied after 40 weeks of age.

Egg weight and density were not affected in the different programs. These results were also reported by Yuri *et al.* (2016) testing continuous and intermittent lighting programs not observing effects on egg weight and density. Koelkebeck *et al.* (1986) also indicated that egg density is not affected between continuous and intermittent programs applied from 21 weeks of age. Results demonstrate that artificial lighting programs influence egg production, but not egg quality parameters (Jácome *et al.*, 2014), however Xin *et al.* (2021) observed lower egg weight in a lighting program of 16 hours of light and 8 hours of dark compared to a program with 9 hours of light and 15 hours of dark.

CONCLUSION

Intermittent lighting program with two photophases of 2 min equidistant between 16 h can be applied in laying hens from 19 to 38 weeks of age, in decreasing natural photoperiod without affecting the productive performance and the egg quality.

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