Effect of Extreme Light Regime on Production and Characteristics of Egg in Laying Geese

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ABSTRACT : The objective of this study was to investigate the effect of long light regime (20 h light and 4 h dark, 20L:4D) and short light regime (4 h light and 20 h dark, 4L:20D) on egg production and egg characteristics of laying geese. Thirty-six laying birds, 4 replicates of 3 birds per treatment were allotted to three light regimes, i.e., 20L:4D, 4L:20D, and natural light (NAT) from March 7 to June 20. Results showed that the geese in 20L:4D consumed 54 g less feed per goose daily and laid 17.5 less eggs per goose ($p<0.05$) comparing to those in 4L:20D. The number of days from initiation of light treatment till cease of laying was 22 days shorter ($p<0.05$) in 20L:4D comparing to that in NAT. Five geese (41.7%) in 4L:20D kept laying by the end of applying light regime. Weight and surface area of the eggs in 4L:20D were greater ($p<0.05$) comparing to those in the other two light regimes. It is concluded that the period of egg production in goose could be manipulated by light regime in the ways such as using short light regime of 4 h light daily to prolong egg production through summer and using long light regime of 20 h light daily to induce cease of egg production. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 8 : 1182-1185)***

Key Words : Laying Goose, Light Regime, Egg Production, Egg Characteristics

INTRODUCTION

The goose is characterized as a seasonal breeder under natural lighting conditions (Rosiñski et al., 1996). Depending on the latitudes where they live, the reproductive season starts in late autumn in subtropical area (Wang et al., 1998; Wang et al., 1999) or early spring in temperate area (Gillette, 1976; Sauveur, 1982). From then on, the intensity of egg production increases daily as the stimulus of the length of light day increases gradually (Pingel, 1990) and all geese are out of laying in June (Gillette, 1976; Sauveur, 1982; Wang et al., 1998; Wang et al., 1999). Cessation of egg production is due to an inducement of refractoriness to light. When photorefractoriness is induced, production and release of GnRH are both attenuated (Parry et al., 1997), accompanied by regression of sexual gonads (Pingel, 1990). Wilson and Reinert (1998) also indicated that photorefractoriness and postnuptial molt were both induced by long length of light day.

When geese were subjected to a light day of 8 to 10 h, the period of egg production was extended and the number of eggs produced was increased (Schneider et al., 1980; Rosiñski et al., 1995). Opposed to that, geese exposed to 14L:10D (14 h light and 10 h dark) produce 24 less eggs per goose than those to 11L:13D (Rousselot-Pailley and Sellier, 1990). The results of a previous study showed that the onset of laying of the resting geese would be suppressed after they had been exposed to 14.5L:9.5D from summer solstice (Wang et al., 1998). We also found that the egg production of laying geese could be ceased if they were exposed to the same lighting scheme. Sellier and Rousselot-Pailley (1999) suggested that laying geese exposed to 18L:6D for two weeks during the last part of reproductive season could induce molting. All these observations implied that the light supplied more than 14 h a day will inhibit egg production in breeder geese.

In contrast, initiation of laying in breeder geese could be suppressed if they were exposed to 6L:18D (Kinney et al., 1959) or 7L:17D (Sauveur, 1982) during the resting period. However, decrease of lighting length from 10L:14D to 8L:16D during the laying period in geese caused not only no impairment to egg production but also would have a beneficial effect for prolonging their laying period (Sellier and Rousselot-Pailley, 1999).

As previously described, the reproductive performance of laying geese are at optimal status as they are exposed to light day of 8 to 10 h and are inhibited when light day is longer than 14 h. On the other hand, the effect of the more extreme lengths of light day, i.e., shorter than 6 h or longer than 18 h on egg production in laying geese has not been well elucidated yet. Thus, this experiment was conducted with three treatments, i.e., long light day of 20 h (20L:4D), short light day of 4 h (4L:20D), and natural light day (NAT) to investigate the effects of more extreme lighting regimes on both egg production and egg characteristics, for the latter such as shell thickness, shell percentage, and whole egg breaking strength in laying geese.

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MATERIALS AND METHODS

White Roman female goslings, obtained from Changhua Animal Breeding Station, COA-TLRI, were reared in floor pens under natural lighting conditions for 20 weeks and followed by growing in cages (40 cm width×51 cm depth× 66 cm height) thereafter. When laying intensity went up to 25% at 38 wk of age, thirty-six laying geese were allotted into three treatments of lighting regimes, i.e., 20L:4D, 4L:20D, and natural light (NAT). For each treatment, twelve laying birds were separated into 4 replicates and each with 3 birds. The geese in 20L:4D and 4L:20D were transferred into light-proof houses to get acclimated for 5 weeks. During the acclimating period, the birds were exposed to a light day of 11.5 h (from 06:30 to 18:00), which was the length of natural light day at the beginning of this period according to the data provided by the Central Weather Bureau, Taiwan, ROC. Thereafter, the geese in 20L:4D and 4L:20D were exposed to 20 h and 4 h of artificial light day, respectively. The artificial light of 40 to 50 lx in illuminating intensity was generated with 7 10-watt fluorescent lights. The NAT served as a control lighting regime throughout the entire experimental period. The light days, including dawn and dusk, of NAT were between 12.5L:11.5D and 14.5L:9.5D in the experimental period.

The birds had free access to drinking water and rations. The concentrations of crude protein (CP) and metabolizable energy (ME) of the rations were 20% CP and 12.13 MJ ME/kg for 0 to 4 weeks of ages, and 16% CP and 11.51 MJ ME/kg for 5 to 16 weeks of ages, respectively. The ration containing 13% CP and 10.84 MJ ME/kg was for the birds from 17 weeks of ages on till onset of laying and for the birds in resting stage also. During egg production, the geese were fed with a ration containing 18% CP and 11.51 MJ ME/kg.

The data of egg production and egg weight were collected daily. Body weight and feed consumption were measured weekly. Eggs collected were stored at 12°C in a cooling room. For each treatment group, up to 10 eggs were randomly sampled weekly for determining their characteristics such as surface area, shell percentage, shell thickness, and whole egg breaking strength. The length and breadth of the eggs were measured with a digimatic caliper (Series 500, Mitutoyo Corporation, Japan). The surface area of egg was calculated as $k\,(\pi\times\text{egg length}\times\text{egg breadth}^2/6)^{0.67}$, where k is 4.63 or 5.07 (Etches, 1996). The whole egg breaking strength was determined at the blunt end erecting up of the egg using a tensile strength tester (HT-8116, Hung Ta Instrument Co. LTD., Taiwan, ROC.), of which the testing speed was set at 30 mm/min, accompanied with an adapter (U3B1-50K-B, Minebea Co. LTD., Singapore). After being removed off content and shell membranes, the shells of the eggs were dried at 102°C and their dried weights were measured. The thickness of eggshell was calculated as average from the measurements at three points, the blunt end, the equator and the sharp end of the egg, with a micrometer (FHK FN-595, Ozaki Manufacturing Co. LTD., Japan).

Data obtained were statistically analyzed using the General Linear Models of Statistical Analysis System (SAS Institute, 1996). The significance of the differences among the means were tested by the Least Squares Mean.

RESULTS

The effects of the lighting regimes on body weight, feed consumption, and egg production of the laying geese were shown in table 1. There were no significant differences among the lighting regimes in body weight loss during the experimental period. The geese in 20L:4D consumed 54 g/bird/day ($p<0.05$) less feed and laid 17.5 eggs/goose ($p<0.05$) less eggs in comparison with those in 4L:20D. It took 22 days less ($p<0.05$) for the geese in 20L:4D comparing to those in NAT to be out of laying after administration of the lighting regimes. There were, however, five geese (41.7%) in 4L:20D still kept laying till the end of the experiment.

The influence of lighting regimes on egg characteristics was shown in table 2. The differences in shell thickness, whole egg breaking strength, and shell percentage were not significant among the lighting regimes. However, the egg weight was heavier and the egg surface area was larger in 4L:20D ($p<0.05$) in comparison with those in the other two lighting regimes. All measurements of egg characteristics were not significantly different between 20L:4D and NAT.

Table 1. Effects of 20L:4D and 4L:20D on body weight loss, feed consumption and egg production in laying White Roman geese

Item	Treatment[1]			SEM
	20L:4D	NAT	4L:20D	
Initial body weight, kg	4.95	4.86	4.89	0.20
Final body weight, kg	4.37	4.39	4.62	0.24
Change in body weight, %	-11.7	-8.4	-5.2	3.37
Feed consumption, g/bird/day	163[b]	170[b]	217[a]	7
Number of eggs laid per goose	8.9[b]	18.9[ab]	26.4[a]	3.7
Duration for geese to out of lay, day	23[b]	45[a]	-[2]	7

[1] 20L:4D, 4L:20D, and NAT were the geese exposed to 20 h light day, 4 h light day, and natural light, respectively.

[2] Five geese out of 12 in 4L:20D continued to lay till the end of this experiment.

[a,b] Values within the same row without the common superscripts differ significantly ($p<0.05$).

Table 2. Effects of 20L:4D and 4L:20D on egg characteristics in White Roman geese

Item	Treatment[1]			
	20L:4D	NAT	4L:20D	SEM
Sample size, eggs	42	56	56	
Egg weight, g	140[b]	140[b]	149[a]	2
Surface area of eggs*, cm^3				
k=4.63	119[b]	119[b]	125[a]	1
k=5.07	131[b]	131[b]	136[a]	1
Shell thickness, μm	557	561	555	5
Whole egg breaking strength, kg	8.1	8.0	7.9	0.3
Shell percentage, %	11.2	11.1	10.8	0.1

[1] 20L:4D, NAT and 4L:20D were the geese exposed to 20 h light day, natural light day and 4 h light day, respectively.

* Egg surface area=$\kappa(\pi\times\text{egg length}\times\text{egg breadth}^2/6)^{0.67}$ (Etches, 1996).

[a,b] Values within the same row without the common superscripts differ significantly ($p<0.05$).

Egg production curves of the laying geese under different lighting regimes were shown in figure 1. The birds in NAT were out of laying in early June. The geese in 20L:4D arrived at a peak of egg production percentage around 40% at one week right after the administration of the light regime. But egg production of the geese in 20L:4D was rapidly declining thereafter animals were rapidly out of laying. In contrast, the geese in 4L:20D were the least ones in egg production at the same stage of the early experimental period. But their egg production recovered soon after the administration of light regime began, and egg production persisted for more than 3 months.

DISCUSSION

Previous research demonstrated that geese reared under natural lighting conditions were out of laying in early June (Gillette, 1976; Sauveur, 1982; Wang et al., 1998; Wang et al., 1999). Similar result was observed for the NAT group as shown in figure 1. It might be thus attributable to photorefractoriness that terminated the reproductive activity in laying geese under the increasing natural light length during summer.

However, the two lighting regimes exerted quite different effects on egg production and characteristics in laying geese (figure 1). Reproductive activity of the laying geese exposed to 20 h light day were immediately accelerated so that the peak of egg production, leading to the other two lighting regimes, occurred within a week after exposing to the light regime. And the egg production dropped dramatically thereafter and out of laying occurred within 5 weeks right after exposure. The geese exposed to 20L:4D stopped laying egg within a month right after arriving at the peak of egg production.

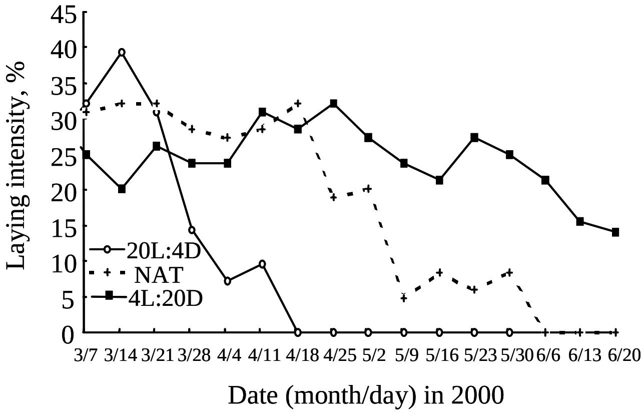

Figure 1. Laying intensity (% of bird) in White Roman goose under 20L:4D (○), natural light day (+) and 4L:20D (■).

In contrast, although the reproductive activity depressed temporarily right after exposing to 4 h light day, the laying intensity recovered the level achieved before exposing to the light regime within 2 weeks and maintained it over 20% for 13 weeks thereafter.

Sellier and Rousselot-Pailley (1999) indicated that the decline of light day during laying period would not result in adverse effect on egg production. It might even increase the period of egg production in geese. In this experiment, the geese in 4L:20D laid 17.5 more eggs per goose (table 1) and extended the laying period for more than 2 months than those in 20L:4D and for one month compared to those in NAT (figure 1). These results supported the viewpoints by Sellier and Rousselot-Pailley (1999).

Sharp (1993) proposed a model of avian photoperiodic response for northern temperate zone. When birds are shifted from short days to long days, both stimulatory and inhibitory inputs to the GnRH-I neurons are activated. Of these two types of inputs, the stimulatory one is activated immediately after change of lighting, while the other develops slowly. Extended exposure to long days would induce a photorefractoriness. Production and release of GnRH would then be attenuated (Parry et al., 1997), and sexual gonads would consequently regress (Pingel, 1990), resulting in out of laying and molting. In contrast, in birds exposed to short days for a long period, the secretion of GnRH is independent from light (Sharp, 1993) since short days do not actively inhibit the activity of GnRH-I neurons (Sharp, 1996). The photoperiodically neutral extension of the laying period of the geese in 4L:20D even could be delayed beyond June, the limit of laying period in geese under natural lighting conditions (Gillette, 1976; Sauveur, 1982; Wang et al., 1998; Wang et al., 1999). The present observation suggests that laying geese continually exposed to short days could also develop photorefractoriness, which is depending on the length of time exposing to short days. The results of the present study supported that the model proposed by Sharp (1993) could be suitable for prediction of the response of laying geese to photoperiod.

Body weight loss was not significantly different among the lighting regimes though the geese in 4L:20D seems to loss less. The results might be attributed to that the activity of GnRH-I neurons in laying geese is independent from short days, and that feed consumption was increased to meet the nutrient requirement for increased egg production.

It has been well documented that the increase of individual egg weight is closely associated with the intake of nutrients, such as protein (Summers and Leeson, 1985), methionine (Petersen et al., 1983), and linoleic acid (Scragg et al., 1987). The geese in 4L:20D produced the heaviest egg but the shell thickness, the whole egg breaking strength, and the shell weight percentage were not different among the three lighting regimes. These results were not consistent with those by Lewis et al. (1994) who indicated that egg weight was negatively correlated with shell thickness. This conflict might be due to the increase of calcium intake along with the increased feed consumption of the geese in 4L:20D, so that the egg characteristics measured were maintained similar even the egg weight increased.

In this study, the laying geese exposed to 20 h light day were out of laying by 23±4 (mean±SE) days after administration of the light regime whereas the birds exposed to 4 h light day were extended their egg production period. It is therefore concluded that short light day of 4 h is able to prolong the duration of egg production beyond summer. Opposed to that, long days of 20 h light may be recommended to stop egg production in laying geese within a month after administration of the lighting regime. The duration of egg production in laying goose may be consequently manipulated through increase or decrease the length of light day, depending on the intention of goose farm manager.

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