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Effects of short light regimes and lower dietary protein content on the reproductive performance of White Roman geese in an environment-controlled house

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ABSTRACT

The objective of this study is to investigate the effects of short light regimes and lower dietary protein content on the reproductive performance of White Roman geese in an environment- controlled house. Thirty-two ganders and 80 geese during the third laying period were allotted into 16 pens, randomly assigned into a split-plot design with two different lighting regimes: (1) short light regimes (SL) with 6.5 h of light and 17.5 h of dark (6.5L:17.5D), and (2) long light regimes (LL) with 19L:5D during the 6-wk prelaying period, followed by two different levels of protein diets (Low CP: 15% *vs.* High CP: 18%) for the laying period. The results showed that birds treated with the SL light regime had a heavier body weight compared to those treated with LL at the arrival of the peak period of egg production (6.19 *vs.* 5.87 kg, $P < 0.05$). Geese under LL had a longer laying period than those under SL treatment (277 *vs.* 175 day, $P < 0.05$), while the geese under SL treatment had a higher laying intensity (15.4% *vs.* 12.6%, $P < 0.05$), fertility and hatchability than those under LL treatment. Our results suggest that the White Roman geese treated with 6-wk short light regime during the prelaying period and on the low CP diet during the laying period found conditions sufficient to sustain their regular reproduction performance, which would benefit geese farmers in the perspectives of energy saving and prolonged laying period.

1. Introduction

The domestic goose shows an obvious seasonal pattern of reproductive activity under natural lighting conditions (Zeman et al., 1990). The reproductive season starts in late autumn in subtropical areas (Wang et al., 2005, 2009), or early spring in temperate areas (Gillette, 1976). For Landaise grey goose, laying intensity rises from zero in January to 50% in April to May (Mialon-Richard et al., 2004). In addition to genetics, environmental conditions also play an important role in poultry reproduction performance. For instance, birds fed with a high protein diet during the laying period show a heavier body weight and egg weights (Robey et al., 1988; Joseph et al., 2000, 2002). It is known

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that the age at first egg (AFE) in poultry is associated with photostimulation, in which light source, spectra, intensity, photoperiod and regimen have been proposed as factors manipulating chicken reproduction performance in modern chicken farms (Lewis et al., 1999a,b, 2008).

Light plays a pivotal role in vision and the release of various hormones; it also increases the efficacy of important factors related to the behavior and reproduction of birds (Biyatmoko, 2014). It is practical and economically profitable to manipulate the initiation of egg laying, as well as to increase the egg production of geese. In poultry, the influence of the photoperiod on AFE appears to involve sequential changes in a negative feedback control of the steroid hormones on gonadotrophin release (Lewis et al., 1999b, 2001; Wang et al., 2002a,b). Wang et al. (2002a,b) reported that the AFE of the geese with longer photoperiod (18L:6D) in May was significantly delayed for 115–163 days compared to that under shorter photoperiod (14L:10D) in January under natural (solar) lighting. Wang et al. (2009) proposed a supplementary lighting program with a total daily photoperiod of between 12.0–13.5 h. The geese under supplement lighting group had 47.6 egg/goose compared to the natural lighting group's 26.4 egg/goose. This result suggested that the decrease in the number of goose eggs is associated with the regulation of the photoperiod equal to or longer than 14L:10D (Hsu et al., 1990). All of these results implied that the effective photoperiod for stimulating an earlier initiation of egg production falls within a narrow range somewhere between 8L:16D or 14L:10D. The photoperiod not only plays an important role in initiating egg production, but also in sustaining the persistency of egg production. It has shown that the geese under a lighting regime of 9L:15D produced at least 18 more eggs than those under 11L:13D and 29 more eggs than those under 13L:11D (Chang et al., 2012). Although a longer photoperiod during the egg production period, such as 13L:11D, can initiate an earlier starting day of laying and a more intensive laying intensity, it also causes a shorter laying period (71–80 days less), which results in less egg produced in the end.

Manipulating the lighting regime has become a common practice to adjust the reproduction performance by geese farmers in Asia. In China, geese are kept outdoors during the prelaying period for 2–2.5 months under a long photoperiod of 18L:6D with natural lighting and supplementary artificial lighting (80–100 lx), followed by an indoor short photoperiod of 11L: 13D during the laying period to induce laying (Sun et al., 2007). On the contrary, in Taiwan, the common practice to induce egg production is to raise geese with a short lighting regime of 7L: 17D for 6 weeks during the prelaying period, followed by a long lighting regime of 9L:15D during the laying period. Geese treated this way start laying egg within 1 month after the increase of photoperiod (Chang et al., 2015).

For geese in an environmentally-controlled house (ECH), the reproductive performance and nutrients metabolism are influenced by the photoperiod pattern in the house. Therefore, the nutrient requirement may presumably not be the same as that under an outdoors raising system. During the laying period, diets containing 15% CP and 2900 ME/kg are recommended for geese (NRC, 1994), while geese diets containing 18% CP and 2650 kcal ME/kg are commonly applied in Taiwan. Wang et al. (1999) report that the thickness and strength of eggshell in geese fed a diet of CP 18% and 2901 ME/kg were better than those of CP 15% and 2903 ME/kg. Nevertheless, Rosiñski et al. (2006) indicate that during the reproductive period, birds were fed *ad libitum* complete diets which contained 14–15% crude protein and 10.48–10.90 MJ EM/kg. There is almost no accessible information, to our knowledge, about the nutrient requirements for laying geese kept in the ECH. Although high CP diet could improve the thickness and strength of eggshell in-season production, diet increasing nitrogen by an excess of CP will affect the environment (Latshaw and Zhao, 2011) and increase feed cost. In a controlled in-door environment, the CP content of diet could be lowered by stable feeding in an ECH. In addition, we hypothesize that the egg number per goose could be modulated by photoperiods during the prelaying period and by the protein level during the laying period in ECH. Moreover, the production costs could be reduced during the rearing geese period, and the egg number and feed components during the laying period. The objectives of this study were, therefore, to find the least expensive way for suitable geese breeding combination of short light regimes during the prelaying period and lower dietary protein during the laying period for White Roman geese kept in an ECH.

2. Material and methods

2.1. Animal management

The care and use of all geese were according to the Regulations of Laboratory Animals, Changhua Animal Propagation Station, Livestock Research Institute, Council of Agriculture, Taiwan. A total of 32 ganders and 80 dams in their third laying season with an average age of 2.7 years old were allotted into 16 pens, each with two ganders and five dams.

Once the birds were moved into the ECH, the lighting photoperiod of either 6.5L:17.5D (SL) or 19L:5D (LL) and a restricted amount of resting ration (13% CP and 2350 ME/kg) were administered according to the experimental proposal for 6 weeks as the two prelaying photoperiod treatments. Thereafter, the photoperiod was adjusted to 9L:15D and the laying diets containing 15% or 18% CP and 2650 kcal ME/kg (Table 1) were fed *ad libitum* for both treatments. The drinking water was provided *ad libitum* all the time.

The ECH for experiment geese is completely controlled and windowless: lighting fully controlled by using fluorescent lamps, tunnel ventilation alone (Negative-Pressure Ventilation) and solid side walls. In the ECH, the geese were raised on plastic-floored pens, each 196 cm in width and 240 cm in length, with the ambient temperature maintained at 28 °C during resting and laying periods. Artificial light comprised seven 60W fluorescent tubes to make the illuminating intensity at the height of standing bird head ranging between 30 and 40 lx. The wind flow was set about 1 m/s.