



## Impact of different artificial light intensities on some reproductive, productive performance aspects and blood picture of male quail

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### Abstract

This experiment was designed to determine the influence of various white light intensities on spermatogenesis, hematology and growth performance of male quail. A total of 80 birds of one day aged had been assigned to four equal groups: G1 control group was kept under natural light program 12h light:12h dark. G2, G3, G4 were exposed to artificial white light emitting diodes at 0.6, 45 and 25 Lux for 5 hours daily for 8 weeks starting at 14 days of age. The result showed that the application of Lux 0.6, 45 and 25 caused a significant increase in heart weight relative to control. Lux 0.6 led to decrease in total body weight, left testis weight and foam weight. The result revealed that exposure to 0.6 Lux caused significant decrease in sperm count and live sperm percentage and increase in dead sperm percentage. Program of 25 Lux generated a significant increase in RBC counts compared to 0.6 Lux. Exposure to 45 Lux and 25 Lux triggers a significant increase in PCV and hemoglobin concentrations. Exposures to 0.6 Lux and 25 Lux resulted in a significant increase in mean corpuscular hemoglobin concentration, while apply to program 0.6 Lux cause increase in stress index. The best feed conversion ratio was detected in normal daylight, 0.6 Lux and 25 Lux respectively. In conclusion, exposure of male quails to different intensities of white LED bulb had an effect on the some physiological and reproductive parameters.

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### Introduction

Many physiological functions are affected by light, which is a vital part of the physical environment (1). Light could be affected quail development, physiological efficiency, reproduction and behavior (2). Light is consisting of three different aspects: intensity, photoperiod (duration) and wavelength (color), so both photoperiod and light intensity are essential environmental factors, light intensity, color and photoperiodic regime will influence the functioning of broiler chickens (3). Light Emitting Diode (LED) bulbs help in providing lower energy consumption and long lifespan than standard incandescent and fluorescent lamps and could be an effective lighting choice throughout the poultry industry (4). In the poultry industry, artificial lighting was widely used to improve production

and reproductive performance (5). Natural or artificial light has been one of the environment factors which affect the growth, reproduction and welfare of poultry by modulating different bird behaviors and physiological functions (6). Poultry has vision-sensitive retinal photoreceptors, while non-visual (extra-retinal) photoreceptors are able to detect and adapting photoperiods to the environment (7). Light stimulate the GnRH pathway directly which increases the quantity of gonadotropins that accelerates sex organ growth, about the same time, the rise in the length of the day reduces the amount of melatonin and reduce inhibition on the stimulating axis. Increased photoperiod increases the sexual maturity of chicks due to stimulation of gonadotropin and sex hormone secretion with subsequent increase in output (8). LEDs are one of the most energy-efficient light supplies and can be produced to provide

certain and stable spectral performance (9), and are absolutely dimmable (10). The birds possess fully advanced visual systems and most of their behaviors are regulated by their vision (11). The lighting is a main factor in bird development, whose function is to stimulate the development of the bird's reproductive system and locomotive activity to higher food and water intakes (12).

Several studies were carried out to investigate the effect of different light intensities on the efficiency of quail growth and reproductive system, but still the lack of knowledge regarding the light impact on quail results, perhaps the aim of the current study is to investigate the influence of various light strength intensity applications on reproduction and growth of male quail.

## **Materials and methods**

### **Birds**

The study was Performed at the animal house of the College of Veterinary Medicine, University of Mosul, Iraq during spring season. A total of 80 one-day Japanese quails have been ordered from the Ebaa Research Center, Ministry of Agriculture. Quails were randomly assigned to four groups, 20 birds each group, where four treatments were administered with 4 replicates. The quails were housed in vertically and horizontally isolated floor pens in order to prevent interference and reflection of the various light sources and the room temperature ranged from 20°C to 27°C. The relative humidity ranged from 45 to 60%. During the rearing and development cycles 8 weeks, clean drinking water *ad libitum*, basal diet ingredient was supplied according to National Research Council (NRC) recommendation (13).

A lighting system of 5 hours of artificial light for 5 days/week has been used. According to the procedure, each space provided the amount of light. The intensity of light available at the top of the bird's head was measured using a digital light meter in various parts of the cages to create a photometric Lux sensor at the head level (14).

### **Experimental design**

The research was conducted during the spring season. Quails were separated into 4 groups: G1, control group were introduced to normal lightening cycle 12 h light :12 h dark. G2 quails dark group were exposed to 0.6 Lux, while G3 and G4 were exposed to 45 and 25 Lux respectively. G3 and G4 were exposed to different light intensity for 5 hours daily from 9:00 a.m. to 2:00 p.m. 5 days/week for 8 weeks starting at 14 days of age.

### **Internal organ weights**

Birds were sacrificed just at the end of the experiment. Visceral organs, including (the heart, liver, gizzard, chest muscle, and testis) and foam material from foam gland were weighted (Weighed and recorded as organ weight/100 g body weight) (15).

### **Gonadosomatic index (GI)**

Determined by the following equation  $GSI = [\text{gonad weight} / \text{body total tissue weight}] \times 100$  (16).

### **Growth performance parameter**

The initial body weight, final body weight, and total feed intake/quail and food conversion ratio (FCR) were recorded weekly, and the foam material from the cloacal glands weight was recorded (17). Foam obtained by each group of birds was collected and its weight was immediately calculated using a digital analytical balance (18).

### **Blood sampling**

Blood samples were collected during slaughter and divided into two parts: one to obtain serum separated by blood centrifugation for 15 min at 3000 rpm. Serum samples were kept at -20°C until estimation of triiodothyronine (T3) hormone concentration (VEDA. LAB France Patch number 27088-08) using the spectrophotometer dry cassette. While blood with anticoagulant was used for complete blood constituents including RBCs and WBCs using Natt and Herrick solution (19), PCV, Hb, MCV, MCH, MCHC, differential leukocytic count (DLC) and stress index using Wright stain (20,21).

### **Sperm parameters**

Semen was taken immediately after the decapitation of the bird by a slight pressure on the ductus deferens from the epididymis ductus to the base of the duct phallus. After that semen diluted with normal physiological saline and spermatogenesis parameters was done including number, live, dead and abnormal sperms (22).

### **Statistical analysis**

Data was analyzed by means of a one-way analysis of variance (ANOVA). The significance of variations among means was assessed by using the Duncan Multiple Range Test at  $P < 0.05$  (23).

## **Results**

Table 1 showed that the application of 0.6 lux, 45 Lux and 25 Lux light intensity for 5 hours a day created a significant increase in heart weight compared to the control group. 0.6 Lux light program application caused significant decrease in body weight as compared to other groups. 25 Lux exposure causes a significant increase in liver weight associated with 0.6 lux.

There is no significant change in gizzard weight among the groups. Application to 0.6 Lux significantly raises the chest weights as compared to the other light program groups.

Table 1: Impact of various artificial light levels of intensity on male quail's body weight and relative organs weight

Treatment	Mean (g/100 g.bw) ± SE				
	body weight (g)	Heart weight	Liver weight	Gizzard	Chest weight
Control	216.2 ±5.54 a	0.77 ± 0.02 c	1.62 ± 0.02ab	1.26 ± 0.02 a	21.24± 0.3 ab
0.6 Lux	191 ± 3.96 b	0.90 ± 0.05 b	1.42 ± 0.08 b	1.49 ± 0.20 a	22.11 ± 0.23 a
45 Lux	214 ± 5.56 a	1.07 ± 0.02 a	1.75 ± 0.02ab	1.60 ± 0.02 a	20.44 ± 0.21 b
25 Lux	220.8 ±3.4 a	1.07 ± 0.01 a	1.80 ± 0.21 a	1.59 ± 0.09 a	20.63 ± 0.41 b

Values shown as mean ± SE. Small different letters in the column denote significantly at P<0.05 between groups.

Attempting to apply male quail to 0.6 Lux resulted in a significant decline in the weight of the left testis in comparison with other groups; Whereas the weight of the left testis did not change significantly when applied to 45 Lux and 25 Lux according to the control value. No significant change between groups in the weight of the right testis. The data did not indicate any significant change in the gonadosomatic index between control, 0.6 Lux and 25 Lux. Furthermore 45 Lux exposure resulted in a significant increase in the gonadosomatic index associated with 0.6 Lux and 25 Lux. Exposure to Lux 0.6 caused a significant reduction in the weight of the foam material from the foam gland compared to other groups, there was non-significant differences in the weight of foam material between control, 45 Lux and 25 Lux as compared between each other's. whereas 0.6 Lux caused significant decrease in foam weight as compared with other groups (Table 2).

Table 3 revealed that exposure to 0.6 Lux resulted in a significant reduction in sperm count and live sperm count, with a significant increase in dead sperm compared to control group, whereas there were no significant changes in sperm count, live sperm count and dead sperm count when applied to 45 Lux and 25 Lux compared to control. No significant difference between groups in abnormal sperm counts and triiodothyronine hormone level.

The current study showed no significant changes in the RBC count for 0.6 Lux, 45 Lux and 25 Lux compared to the control group. Application for 25 Lux causes a significant increase in RBC counts compared to 0.6 Lux. There is no significant difference between groups in the WBC count exposure to 45 Lux and 25 Lux caused significant increase in PCV value compared to the control group, while exposure to 0.6 Lux caused significant decrease in PCV value compared with other groups. Applying to 45 Lux and 25 Lux results in a significant increase in hemoglobin concentrations compared with 0.6 Lux and control groups (Table 4).

Table 5 showed no variation between groups in the erythrocyte index except for 45 Lux and 25 Lux program exposures, which resulted in a significant increase in the mean hemoglobin concentration compared to 0.6 Lux and the control value.

The result clarified in table 6 applies to program 0.6 Lux, caused significant decrease in the percentage of lymphocytes accompanied with a significant increase in the percentage of heterophils as compared to other groups. No significant changes between groups in the percentage of basophilic or eosinophilic. There is a significant increase in the monocyte percentage and stress index for 0.6 Lux relative to other groups.

Table 2: Impact of various artificial light levels of intensity on male quail's sex relative organs weight

Treatment	Mean ± SE			
	Left testis weight	Right testis weight	Gonadosomatic index	Foam weight
Control	1.67 ±0.04ab	1.57 ± 0.09 a	1.50 ± 0.05ab	0.026 ± 0.002 a
0.6 Lux	1.20 ± 0.03 c	1.34 ± 0.14 a	1.33 ± 0.11 b	0.012 ± 0.002 b
45 Lux	1.89 ± 0.14 a	1.69 ± 0.11 a	1.66 ± 0.11 a	0.024 ± 0.002 a
25 Lux	1.51 ± 0.07 b	1.50 ± 0.07 a	1.36 ± 0.06 b	0.030 ± 0.003 a

Values shown as means ± SE. Small different letters in the column denote significantly at P<0.05 between groups.

Table 3: Impact of artificial light levels of intensity on male quail's spermatogenesis and triiodothyronine hormone level

Treatment	Mean ± SE				
	Sperm count 10 <sup>6</sup> /mm <sup>3</sup>	Live sperm %	Dead sperm %	Abnormal sperm %	Triiodothyronine (ng/ml)
Control	2.15 ± 0.14 a	75.60 ± 2.94 a	24.40 ± 2.94 b	3.80 ± 0.96 a	0.88 ± 0.17 a
0.6 Lux	1.32 ± 0.13 b	52.80 ± 8.23 b	47.20 ± 8.23 a	5.20 ± 1.46 a	1.22 ± 0.38 a
45 Lux	2.48 ± 0.16 a	78.00 ± 3.49 a	22.00 ± 3.49 b	3.204 ± 0.80 a	0.90 ± 0.77 a
25 Lux	2.46 ± 0.13 a	78.00 ± 3.88 a	21.60 ± 3.88 b	2.80 ± 0.58 a	0.94 ± 0.08 a

Values shown as means ± SE. Small different letters in the column denote significantly at P<0.05 between groups.

Table 4: Impact of various artificial light levels of intensity on male quail's blood constituent

Treatment	Mean $\pm$ SE			
	RBC $\times 10^6/\text{mm}^3$	WBC $\times 10^3/\text{mm}^3$	PCV %	Hb g/100ml
Control	3.60 $\pm$ 0.16ab	3.43 $\pm$ 0.40 a	50.80 $\pm$ 0.48 b	9.67 $\pm$ 0.31 c
0.6 Lux	2.83 $\pm$ 0.27 b	4.11 $\pm$ 0.21 a	43.40 $\pm$ 1.02 c	9.18 $\pm$ 0.17 c
45 Lux	3.60 $\pm$ 0.24ab	4.18 $\pm$ 0.12 a	58.40 $\pm$ 0.74 a	10.79 $\pm$ 0.16 b
25 Lux	4.22 $\pm$ 0.28 a	3.70 $\pm$ 0.29 a	60.60 $\pm$ 1.16 a	13.19 $\pm$ 0.59 a

Values shown as means  $\pm$  SE. Small different letters in the column denote significantly at  $P < 0.05$  between groups.

Table 5: Impact of various artificial light levels of intensity on male quail's erythrocyte indices

Treatment	Mean $\pm$ SE		
	MCV fl	MCH pg	MCHC g/100ml
Control	142.11 $\pm$ 5.63 a	26.98 $\pm$ 6.44 a	18.42 $\pm$ 0.80b
0.6 Lux	158.04 $\pm$ 13.19 a	30.64 $\pm$ 2.61 a	18.51 $\pm$ 0.49b
45 Lux	165.71 $\pm$ 13.56 a	31.87 $\pm$ 2.52a	21.08 $\pm$ 0.11a
25 Lux	145.18 $\pm$ 6.93 a	33.40 $\pm$ 2.87 a	21.82 $\pm$ 1.22a

Values shown as means  $\pm$  SE. Small different letters in the column denote significantly at  $P < 0.05$  between groups.

Table 6: Impact of various artificial light levels of intensity on male quail's differential leucocytic count and stress index

Treatment	Mean $\pm$ SE					
	Lymphocyte %	Heterophils %	Basophil %	Eosinophil %	Monocyte %	Stress index
Control	69.80 $\pm$ 2.22 a	18.80 $\pm$ 2.88 b	0.40 $\pm$ 0.24 a	0.60 $\pm$ 0.40 a	10.40 $\pm$ 1.36 b	0.27 $\pm$ 0.05 b
0.6 Lux	49.20 $\pm$ 5.41 b	27.80 $\pm$ 3.32 a	0.40 $\pm$ 0.24 a	0.60 $\pm$ 0.40 a	22.00 $\pm$ 3.43 a	0.62 $\pm$ 0.16 a
45 Lux	69.60 $\pm$ 2.20 a	18.40 $\pm$ 3.32 b	0.40 $\pm$ 0.24 a	0.40 $\pm$ 0.40 a	11.20 $\pm$ 1.5 b	0.26 $\pm$ 0.05 b
25 Lux	71.40 $\pm$ 1.43 a	15.60 $\pm$ 1.46 b	0.40 $\pm$ 0.24 a	0.60 $\pm$ 0.24 a	12.0 $\pm$ 1.84 b	0.21 $\pm$ 0.02 b

Values shown as means  $\pm$  SE. Small different letters in the column denote significantly at  $P < 0.05$  between groups.

The data in Table 7 do not show a significant variation between groups in the initial weight, final weight and total weight gain. Total feed intake increased significantly in 45 Lux and 25 Lux compared to the control value. Application of light 0.6 Lux causes a significant decrease in total feed intake relative to the other groups. Light intensity did not

significantly improve the feed conversion ratio, and 45 Lux worst group affect the feed conversion ratio compared to other groups. However, the best feed conversion ratio was detected in normal daylight then. 0.6 Lux and 25 Lux respectively.

Table 7: Impact of various artificial light levels of intensity on male quail's growth performance

Treatment	Mean $\pm$ SE				
	Initial weight	Final weight	Total weight gain	Total feed intake	Feed conversion ratio
Control	60.85 $\pm$ 1.45 a	170.35 $\pm$ 9.19 a	109.50 $\pm$ 8.38 a	347.42 $\pm$ 1.18 d	3.23 $\pm$ 0.28 b
0.6 Lux	63.35 $\pm$ 2.57 a	172.45 $\pm$ 5.66 a	109.10 $\pm$ 5.12 a	376.33 $\pm$ 1.17 c	3.40 $\pm$ 0.16 b
45 Lux	61.70 $\pm$ 1.44 a	184.70 $\pm$ 5.89 a	123.00 $\pm$ 7.08 a	620.05 $\pm$ 0.25 a	5.08 $\pm$ 0.28 a
25 Lux	63.90 $\pm$ 1.64 a	182.35 $\pm$ 4.44 a	118.45 $\pm$ 3.39 a	449.00 $\pm$ 0.35 b	3.80 $\pm$ 0.11 b

Values shown as means  $\pm$  SE. Small different letters in the column denote significantly at  $P < 0.05$  between groups.

## Discussion

The current study considers 0.6 Lux intensity to be low light intensity or dim, thus low light levels can reduce physical activity leading to more rest and sleep. Blatchford *et al.* (12) reported that light intensity had a major effect on the growth of broiler chickens. Photoperiods of just fewer than 18 h have been reported to reduce feed

intake (24). The present study found that application to 25 Lux and 45 Lux resulted in a significant increase in breast mass and heart weight. It was also observed previously that breast meat yield increased linearly as the photoperiod rearing treatments increased from 14 light: 10 dark to 23 light: 1 dark (24). Japanese quail photo stimulation with white LEDs is more effective in improving the growth of their organs (25). Yahav *et al.* (26) documented that light

strength had an effect on the weight of the heart muscle, but perhaps not on the weight of the breast meat mass, weight of the testis or weight of the abdominal fat as a proportion of the body weight.

The present study showed that the adjustment to 0.6 Lux dark for 5 hours daily resulted in a decrease in testicular weight and foam material weight, as light is the essential component of the atmosphere that governs the numerous physiological functions of birds (1). Non-natural lighting has also been commonly used in the poultry industry in order to improve production and reproductive performance (5). The present findings did not show any significant differences in testes and foam weight when applied to 25 Lux and 45 Lux compared to the control value. This research did not comply with Retes *et al.* (27), who announced that fluorescent and red LED bulbs had a higher testis weight and a higher quail area of seminiferous tubules at 35 days of age., In addition, fluorescent bulbs have resulted in higher germ epithelium heights at this age, even at 57 days of age, and white LED bulbs have resulted in higher testicular development (27).

Other findings demonstrate that There is a powerful connection between the size of the foam gland and the weight of the testicles; so, the growth of the foam gland could be used as marker of testicular activity (28).

0.6 Lux induced a significant decrease in sperm concentration and live sperm with a large increase in dead sperm, although there were no major improvements in sperm count, live sperm count and dead sperm when applied to 45 Lux and 25 Lux.

Retes *et al.* (29) suggested that different types of lamps did not affect the sperm efficiency and fertility of male quail sperm. The findings of the current study showed no significant differences in RBC counts for 0.6 Lux, 45 Lux and 25 Lux relative to the control group, whereas 25 Lux exposure induces a large increase in RBC counts relative to 0.6 Lux.

Exposure to 45 Lux and 25 Lux causes a significant increase in PCV value relative to the control group, whereas exposure to 0.6 Lux causes a significant reduction in PCV value. The result showed no significant difference between groups in the WBC count.

Applying to 45 Lux and 25 Lux result in significant increase in hemoglobin concentrations compared to 0.6 Lux and control groups. Several researchers have described the effect of light on the hematological parameters of some avian and mammals. Olanrewaju *et al.* (29) concluded that high day exposure to light significantly reduced broiler hematocrit and hemoglobin.

Hassan *et al.* (30), on the other hand, reported that monochromatic lights had no effect on the duck hematocrit but did not indicate the period of exposure to light. Dedeke *et al.* (31) confirmed that tolerance to artificial white light had a significantly lower PCV percent value, also the eosinophil was also significantly higher under yellow light and significantly lowered under control.

There is scientific evidence that various light systems can cause either physiological or psychological stress responses heterophil/lymphocyte broiler ratios have been noted to be unaffected photoperiod (32). The heterophil / lymphocyte ratio is often used as a stress marker in birds (33).

Pervious analysis, documented that H/L ratio of both male and female was found to be higher in the continuous light category. On the other hand, just the variance among male quails was originate to be significant.

Similarly, Moore and Siopes (34) achieved that the H/L ratio was the maximum in continuously light - filled quails. Therefore, the commonly used continuous light system is thought to trigger stress in male quails.

Likewise, Moore and Siopes (34) noticed that the H/L ratio was the maximum for continuously lit quails. Throughout the earlier findings, during which two lighting systems continuous light and 14 light: 10 dark were compared, it was evaluated that the number of heterophils increased and the number of lymphocytes decreased, indicating that chickens were stressed due to the continuous lighting (35).

Furthermore, the larger maximum standard error values for heterophils, lymphocytes and H/L ratio in quails suggest the presence of a wide range individual variation as the lighting program increase that the need for darkness. The data did not indicate a significant difference between the groups in which the quail resistance varies from the artificial light intensity to the initial weight, final weight and total weight gain.

Application of light 0.6 Lux induces a significant decrease in average feed intake compared to other categories. Total feed intake significantly increased in 45 Lux and 25 Lux compared to the control value. Light strength did not significantly improve the feed conversion ratio, and 45 Lux is the worst group affect the feed conversion ratio compared to other groups. However, the best feed conversion ratio was observed in normal daylight, 0.6 Lux and 25 Lux.

Further experimental work has shown that light intensity ranging from 1 to 151 Lux does not affect body weight, feed intake and feed conversion in broiler chickens (36).

Other research indicates that artificial light has beneficial economic effects on quail results. The current study revealed that reaction to different light intensities did not influence the level of triiodothyronine hormone level relative to the control group, this result disagrees with pervious study (37) who found that light induces increased releasing of metabolic hormones, including triiodothyronine, thyroxine, insulin, growth hormone and insulin like growth factor-1.

These hormones have been involved in the growth and enhancement of quail and domestic birds' competitive and reproductive functions.

## Conclusion

The white light intensity affected the study criteria differently, as 0.6 Lux negatively affected the reproductive characteristics as well as the percentage of lymphocytes and heterophil and stress index. While 45, 25 Lux had positive effects on the constituent blood of Male quail.

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## Conflict of interest

The authors declare that there is no conflict of interest

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## أثر شدة الإضاءة المختلفة في بعض أوجه الأداء التناسلي والإنتاجي وصورة الدم لذكور السمان هيام نذير متي، سهى محمود أحمد و أشواق احمد حسن

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### الخلاصة

صممت الدراسة الحالية لمعرفة تأثير شدة الضوء الأبيض على تكوين النطف وصفات الدم وأداء النمو في ذكور طائر السمان. تم توزيع الطيور بمجموع ٨٠ طائر بعمر يوم واحد إلى أربع مجاميع: مجموعة السيطرة عرضت للإضاءة الطبيعية والمجاميع الثانية والثالثة والرابعة عرضت إلى الضوء الأبيض الاصطناعي وبشدة ٠,٦ و ٢٥ و ٤٥ لوكس على التوالي ولمدة ٥ ساعات يوميا ولخمس أيام بالأسبوع ابتداء من اليوم ١٤ من العمر واستمر لثمانية أسابيع. أظهرت النتائج إن التعرض لشدة ضوء ٠,٦ و ٢٥ و ٤٥ لوكس سبب زيادة معنوية في وزن النسبي للقلب مقارنة مع مجموعة السيطرة وسبب شدة ضوء ٠,٦ نقصان في وزن الجسم، ووزن الخصية اليسرى، ووزن المادة الرغوية. أدى التعرض إلى شدة إضاءة ٠,٦ لوكس إلى حدوث انخفاض معنوي في عد النطف، والنطف الحية وزيادة بالنطف الميتة. أدى التعرض لبرنامج إضاءة ٢٥ زيادة معنوية في عد خلايا الدم الأحمر مقارنة مع الإضاءة ٠,٦ لوكس. أحدث التعرض لشدة إضاءة ٢٥ و ٤٥ لوكس إلى حدوث زيادة معنوية في حجم الخلايا المرصوصة وتركيز الهيموغلوبين. نتج من التعرض عند ٠,٦ و ٢٥ لوكس زيادة معنوية في معدل تركيز هيموكلوبين الكرية في حين التعرض إلى ٠,٦ لوكس سبب زيادة في مؤشر الإجهاد. كان أفضل معامل تحويل غذائي عند الإضاءة الطبيعية النهارية تلتها شدة إضاءة ٠,٦ لوكس ومن ثم ٢٥ لوكس. يستنتج إن تعرض ذكور طائر السمان لشدة إضاءة بيضاء مختلفة أثر في بعض المعايير الفسلجية والتكاثرية.