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Effect of Photoperiod on Some Zootechnical Performances of Quail (*Coturnix Coturnix Japonica*) Raised in Cage in Côte D'Ivoire

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Abstract

A study was conducted in Ismorel farm at Adiake, Côte d'Ivoire, to determine effect of photoperiod on some zootechnical performances of the quail (*Coturnix coturnix japonica*). One-day-old quail was separated into two photoperiodic groups, including group A (NL: 12-AL: 12) and group B (NL: 12-AL: 0). After one week of age, each group was divided into two subgroups. Group A was divided into subgroups A1 (NL: 12-AL: 12) and A2 (NL: 12-AL: 4) while group B was divided into subgroups B1 (NL: 12-AL: 0) and B2 (NL: 12-AL: 4). The experiment lasted 18 months with 6 months for a repetition, it ran from November 2016 to May 2018. During this experiment, 2960 chicks were used for the experiment and 2775 eggs were collected to determine fertility rate and hatching rate. Results showed a significant effect ($p < 0.05$) of photoperiod on body weight in favor of group A (NL: 12-AL: 12) and subgroup A1 (NL: 12-AL: 12).

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A significant difference (p <0.05) in photoperiod on egg weight, egg diameter, and egg laying rate was observed in favor of quail in A1 (NL: 12-AL: 12) and B1 (NL: 12-AL: 0). On the other hand, photoperiod had no influence (p> 0.05) on the length of eggs, fertility rate, hatching rate and mortality rate according to different subgroups formed.

Keywords: Photoperiod; zootechnical; performance; quail.

1. Introduction

Japanese quail is a rustic bird raised for dietary and therapeutic virtues of its eggs [1]. Small in size, it is characterized by rapid growth, early sexual maturity, short generation interval, high egg production, and lower requirements (in food and space) than other poultry species [2,3]. All these performances can be influenced by environmental factors. Indeed, zootechnical performance of quail can be influenced by photoperiod, precipitation, humidity, temperature, and diet in addition to intrinsic factors [4,5]. Light is an important factor influencing behavior, egg production, and health of layers [6]. The duration of light affects not only laying, but also laying rate. Growth and ovarian function are associated with increased plasma concentrations of LH and FSH hormones for two to three days of photo-stimulation that stimulate growth of ovarian follicles [7]. Several studies have been conducted on Japanese quail, but little on its adaptation to environmental and livestock conditions in Côte d'Ivoire.

This work will consist in determining the influence of photoperiod onzootechnical performances of Japanese quail (*Coturnix coturnix japonica*). It is specifically the performances of growth, reproduction and mortality.

2. Material and methods

2.1. Site of the study and experimental animals

This study was conducted over 18 months with three repetitions (November 2016 to end of May 2018) in the Ismorel farm located 2 km from the city of Adiaké (5 ° 17'06 "N of latitude and 3 ° 18'07" W longitude) in Ivory Coast. The relative humidity and temperature during the experiment ranged from 75 to 95% and 23.5 to 31.3 ° C, respectively, while the annual precipitation was 1689.54 mm. The quail used in this study comes from the Ismorel farm. Thus 2960 one-day-old quail chicks with an average weight of 7.08 ± 0.5 g were selected.

2.2. Distribution of animals

This work has been done in open cages, allowing the natural ventilation of birds. The chicks were divided into two groups of equal effective and substantially identical body weight (Group A and B with a body weight of 7.11 ± 0.45 and 7.05 ± 0.55 g, respectively).

After a start-up week, each group was subdivided into two subgroups. Subgroups A1 and A2 consisted of 740 chicks for each as well as subgroups B1 and B2. After sexing at 40 days of age, each subgroup were divided into breeding groups consisting of 1 males and 3 females. Thus, three breeding groups were formed per subgroup. Each reproductive group was housed in a cage (Figure 1).

2.3. Photoperiod

The photoperiod was measured in addition to the natural lighting of the day with or without artificial lighting of varying duration. For artificial lighting, bulbs of 30 watts and light intensity of 20 lux were used due to 0.015 m2 / adult quail. Each group underwent a different treatment. Thus, during the start-up stage, Group A was subjected to 12 hours of artificial light when Group B quail was not lit during the night. During the growth stage, the subgroup A1 has received 12 hours of artificial lighting while the subgroupA2 received 4 hours of artificial light. Subgroup B1 was not lit during the night, but subgroup B2 received 4 hours of artificial light (Figure 1).

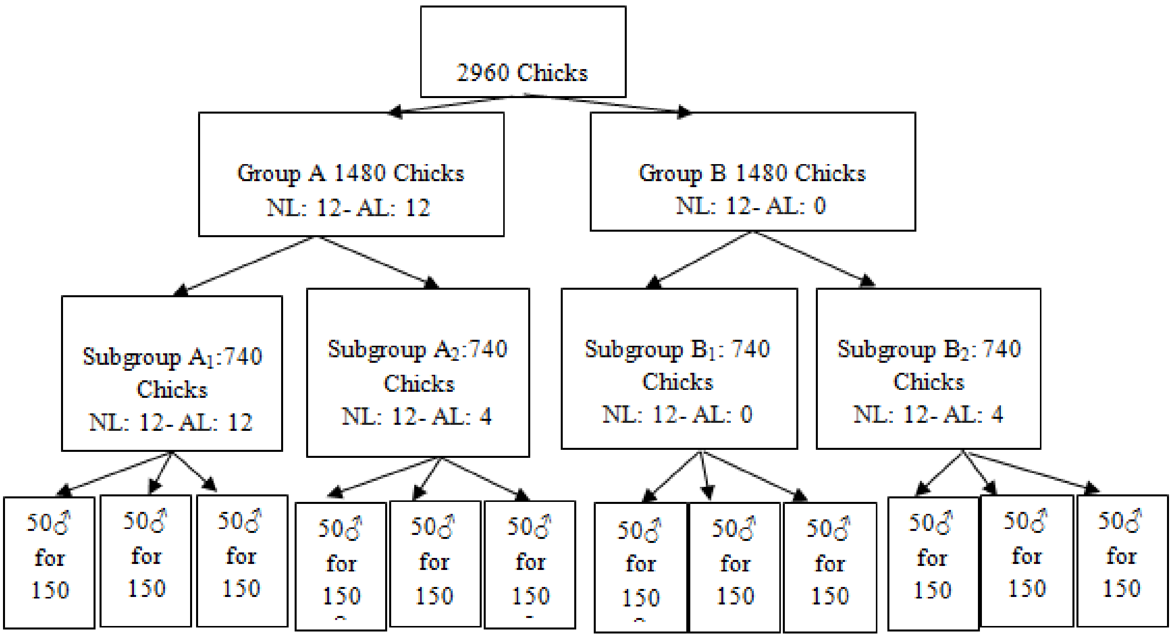

Figure 1: Distribution of animals and different photoperiods (NL: Natural light, AL: Artificial light)

2.4. Conduct

Water and feed were served *ad libitum*.

The feed of quail was made according to the different phases of the breeding.

The raw material composition of the different foods is given in table 1.

Every day, the livestock building was cleaned, as well as the cages, the feeders and the watering troughs.

The incubator and the brooder were cleaned, disinfected and respectively lit and preheated two days before the arrival of the eggs and the arrival of the quail's chicks.

Table 1: Percentage composition of quail feed

	Breeding phases		
Raw material	Start-up	Growth	Clutch
Maize %	58,9	59,8	48,2
Soy %	20	16	16
Corn %	15	18	25
Fish %	1,1	1	2
Shell %	0	0,2	3,8
Premix %	5	5	5
Total %	100	100	100

2.5. Collection of data

The data collected concerned growth and reproduction performances. Growth was evaluated during the start-up (week 0 to 1) and growth (week 1 to 5) phases. Data on weight and feed consumption were collected to determine changes in quail body weight, feed intake, average daily gain, and consumption index. For this, the quail was weighed once a week until the fifth week. On the other hand, the quantities of feed distributed and refusals were weighed daily. Regarding the reproductive performance that was assessed during the laying phase, information was given on the fertility and hatching rate and then the diameter and length of eggs. The diameter and length of eggs were determined after one month of laying using a VERNIER CALIPER precision mechanical caliper of 1 mm precision. The body weight of the quail and the weight of the eggs were taken using a DIGITAL BALANCE electronic scale of sensitivity 1/100 mg. The mortality rate was recorded at start-up, growth and laying. The methods for calculating the different parameters are shown in table 2.

Table 2: Different calculation parameters

Settings	**Formulas**
Mortality rate (MR) =	$\frac{Number\ of\ dead\ subjets}{Number\ of\ subjets\ set\ up} \times 100$
Laying rate (LR) =	$\frac{Total\ number\ of\ eggs\ laid}{Number\ of\ live\ quails} \times 100$
Hatching rate(HR) =	$\frac{Number\ of\ hatched\ eggs}{Total\ number\ of\ eggs\ incubated} \times 100$
Fertility rate (FR)=	$\frac{Total\ number\ of\ embryos}{Total\ number\ of\ eggs\ incubated} \times 100$
Feed intake (FI)=	*(Quantity of feed distributed-Refusal feed) (g)*
Average daily gain (ADG) =	$\frac{Weight\ gain\ (g)}{Number\ of\ day}$
Consumption index(CI) =	$\frac{Quantity\ of\ feed\ consomed\ (g)}{Average\ daily\ gain\ (g)}$

2.6. Data analysis

The statistical analyzes of data were carried out using statistical software R version 3.1.3. To compare different experimental batches, distribution of data obtained (weight and measurement) was analyzed using Agrostino-Pearson test.

Parametric data were compared by performing one-way analysis of variance (ANOVA) followed by Turkey's multiple comparison tests.

The factor of study was photoperiod. Non-parametric data were analyzed with Kruskal-Wallis test followed by Dunn comparison test.

The results of weighing and measurements are expressed on average with the standard deviations. The value of P is set at 5% of the Turkey test and that of Dunn with 95% confidence interval (CI).

3. Results

3.1. Effect of photoperiod on body weight of quails

Quails exposed to artificial light (Group A) during the start-up phase had a higher weight of 1.89 than that with only natural light (Group B).

In growth phase, the A1 group kept under artificial light for 12 hours had the highest weight gain followed by the A2 group (4 h of artificial light).

The lowest weight gain is obtained with group B1 which did not receive illumination during the night. Thus, the groups (A1, A2 and B2) that received artificial lighting had higher sexual maturity weights (Figure: 2) and table 3.

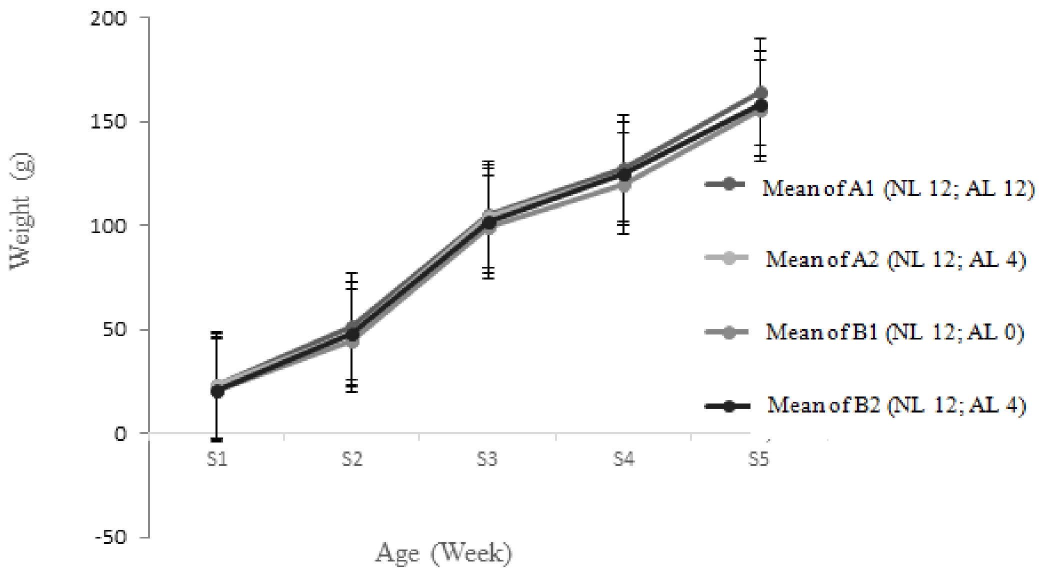

Figure 2: Curve of the evolution of quail weight growth

Table 3: Effect of photoperiod on weight growth of different groups and subgroups of quails

Weekly period	Photoperiod and means weight (g) of quail				P > F
	A NL 12 ; AL 12		B NL 12 ; AL 0		
W_0	7,11± 0,45 [a]		7,05± 0,55 [a]		NS
W_1	22,87 ± 2 [a]		20,98 ± 1,7 [b]		*
	A_1 NL 12 ; AL 12	A_2 NL 12 ; AL 4	B_1 NL 12 AL 0	B_2 NL 12 ; LA 4	
W_2	51,24 ± 4,95 [a]	47,91 ± 4,58 [b]	44,76 ± 4,36 [c]	47,72 ± 4,72 [bc]	* *
W_3	105,19 ± 4,83 [a]	104,22 ± 4,64 [a]	99,36 ± 5,35 [b]	102,12 ± 4,95 [ab]	*
W_4	127,87 ± 4,14 [a]	125,20 ± 4,38 [a]	120,11 ± 5,85 [b]	124,99 ± 3,92 [b]	*
W_5	164,52 ± 7,14 [a]	158,77 ± 5,27 [a]	155,41 ± 5 [b]	158,56 ± 6,53 [a]	*
Average	112,21 ± 5,27[a]	109,03 ± 4,72[a]	104,91 ±5,14[b]	108,35 ± 5,03[a]	*

The mean values designated in line with the different letters (a, b and c) differ significantly at p <0.05; NS: Not significant; Significant difference *; Very significant difference * *

3.2. Effect of photoperiod on feed consumption, average daily gain and consumption index

Feed consumption of quails from the same group showed no difference (p> 0.05) at start-up and growth.

On the other hand, at the finishing phase, a significant difference

(p <0.05) in feed consumption was recorded among all quail subgroups.

Group A1 with 12 hours of artificial light showed higher dietary intake than other subgroups (table 4).

The mean daily gain was similar for the animals in the same group (p> 0.05) during the start-up phase.

During the growth phase, the mean daily gain varied significantly

(p <0.05) for the A1 subgroup with those of the A2, B1 and B2 subgroups.

The average daily gain of quail in A1 was higher than the other A2, B1 and B2 (table 5).

The consumption index was similar to start-up and growth for quail in subgroups A1 and A2 as well as subgroups B1 and B2.

When in the finishing phase, the consumption index was significantly different (p <0.05) for all subgroups A1, A2, B1 and B2. The subgroup B1has obtained the best consumption index (table 6).

Table 4: Average dietary consumption per quail per day

	Consumption (g)/quail/day (M± Sd)			
Photoperiod	Start up 7 days	Growth 14 days	Finish 14 days	Average
A_1 NL 12 ; AL 12	3,07 ± 1,67[a]	11,62 ± 1,91[a]	18,21 ± 1,37[a]	12,55 ± 1,46[a]
A_2 NL 12 ; AL 4	3,07 ± 1,67[a]	10,82± 2,35[a]	16,52 ± 0,98[b]	11,55 ± 1,67[a]
B_1 NL 12 ; AL 0	1,59 ± 0,69[b]	6,52 ± 3,89[b]	14,19 ± 1,55[d]	8,60 ± 2,34[b]
B_2 NL 12 ; AL 4	1,59 ± 0,69[b]	7,49 ± 3,40[b]	15,54 ± 1,47[c]	9,53 ± 2,09[b]

The mean values designated in columns with the different letters (a, b, c and d) differ significantly at p <0.05; M: Mean; Sd: Standard deviation

Table 5: Average Daily Gain (ADG) per quail per day

	ADG (g)/quail/day (M± Sd)			
Photoperiod	Start up 7 days	Growth 14 days	Finish 14 days	Average
A_1 NL12 ; AL 12	2,25 ± 0,00[a]	5,87 ± 0,00[a]	4,24± 0,00[a]	4,49 ± 00[a]
A_2 NL 12 ; AL 4	2,25 ± 0,00[a]	5,38 ± 0,00[b]	4,04 ± 0,0[b]	4,22 ± 00[b]
B_1 NL 12 ; AL 0	1,98 ± 0,00[b]	5,59 ± 0,00[d]	4 ± 0,00[b]	4,23 ± 00[b]
B_2 NL 12 ; AL 4	1,98 ± 0,00[b]	5,79 ± 0,00[c]	4,03 ± 0,00[b]	4,32 ± 00[b]

The mean values designated in columns with the different letters (a, b, c and d) differ significantly at p <0.05

Table 6: Average consumption index (CI) per quail per day

	Consumption index (CI)/quail/day (M± Sd)			
Photoperiod	Start up 7 days	Growth 14 days	Finish 14 days	Average
A_1 NL 12 ; AL 12	1,36 ± 0,74[a]	1,97 ± 0,32[a]	4,29 ± 0,32[a]	2,78 ± 0,4[a]
A_2 NL 12 ; AL 4	1,36 ± 0,74[a]	2,01 ± 0,43[a]	4,09± 0,24[b]	2,71 ± 0,42[a]
B_1 NL 12 ; AL 0	0,80 ± 0,34[b]	1,16 ± 0,51[b]	3,54 ± 0,37[d]	2,04 ± 0,42[c]
B_2 NL 12 ; AL 4	0,80 ± 0,34[b]	1,29 ± 0,58[b]	3,85 ± 0,36[c]	2,22 ± 0,44[b]

The mean values designated in columns with the different letters (a, b, c and d) differ significantly at p <0.05

3.3. Effect of photoperiod on weight, diameter and length of quail eggs

Experimental animals has shown differences (P <0.05) only in egg weight and diameter. Class A1 quails' with a higher mean egg weight (10.32 ± 0.78 g) showed a significant difference (p <0.05) with those of subgroups B1, A2, and B2 (table 7).

The average diameter of the quail eggs in the A1 group indicated a higher value and a significant difference ($p < 0.05$) than those of the other subgroups.

Table 7: Effect of photoperiod on weight, diameter and length of quail eggs

Settings	Subgroup			
	A_1 NL 12 ; AL 12	A_2 NL 12 ; AL 4	B_1 NL 12 AL 0	B_2 NL 12 ; AL 4
Weigth (g)	10,32±0,78 ^{a}	9,80±0,57 ^{c}	9,96±0,80 ^{b}	9,70±0,73 ^{c}
Length (cm)	2,88 ± 0,12 ^{a}	3 ± 1,85 ^{a}	2,85 ± 0,18 ^{a}	2,98 ± 1,85 ^{a}
Diameter (cm)	2,27±0,08 ^{a}	2,23 ± 0,06 ^{bc}	2,25±0,08 ^{b}	2,22±0,07 ^{c}

The mean values designated in line with the different letters (a, b and c) differ significantly at $p < 0.05$

3.4. Effect of photoperiod on the spawning rate of quail

Spawning started in quail of subgroup A1, A2, B2 and B1 respectively 33rd, 35th, 39th, and 40th day of age.

During the first week of hatching, the animals in subgroups B1 and B2 recorded a similar spawning rate (3.47%) which is not different ($p > 0.05$) from that of subgroup A2 according to Table VIII. The average spawning rate for quail in A1 is 5.77 times higher than that for quail in subgroup B1 and B2 (Table VIII).

At the second week, a significant difference ($p < 0.05$) in mean spawning rate was observed between the A and B subgroups. Within each group, there was no difference no difference. Spawning rates were higher for group A. On the other hand, at the third and fourth week, a similarity in the mean spawning rate was recorded between the four subgroups of quails ($p > 0.05$) (table 8).

Table 8: Evolution of the laying rate in the different photoperiodic subgroups as a function of rearing time

Subgroup	Age of entry intolaying (day)	Laying rate %			
		Week 1	Week 2	Week 3	Week 4
A_1 NL 12 ; AL 12	33	20,83 ± 8,21^{a}	70,16±4,79^{a}	84,44±3,85^{a}	95,87±2,75^{a}
A_2 NL 12 ; AL 4	35	11,67 ± 3^{ab}	60,32±13,48^{a}	74,29±9,09^{a}	81,35±9,48^{a}
B_1 NL 12 AL 0	40	3,61 ± 3,76^{b}	42,86±0,95^{b}	82,86±10,98^{a}	87,94±9,05^{a}
B_2 NL 12 ; AL 4	39	3,33 ± 2,2^{b}	40 ± 9,67^{b}	62,86 ± 13,83^{a}	76,51 ± 5,74^{a}

The mean values designated in column with the different letters (a, b and c) differ significantly at $p < 0.05$

3.5. Effect of photoperiod on the fertility and hatching rate of quail eggs

The analysis of the fertility rate data indicates that the different subgroups did not register any significant difference (p> 0.05) between them (chi-2 = 4.753, ddl = 3, p = 0.191) (table 9).

The different subgroups A1, A2, B2 and B1 also did not show any significant difference (p> 0.05) in the hatching rate (chi-2 = 7.815, ddl = 3, p = 0.283) (table 10).

Table 9: Effect of photoperiod on fertility rate of different subgroups

Subgroup	Effective	Eggs with embryos	Fertility rate %	Khi-2	Value P	Sign<0,05 = *
A_1 NL 12 ; AL 12	700	670	95,71			
A_2 NL 12 ; AL 4	670	640	95,52	4,753	0,191	NS
B_1 NL 12 ; AL 0	650	585	90			
B_2 NL 12 ; AL 4	755	705	93,38			

NS: Not significant difference (P> 0.05)

Table 10: Effect of photoperiod on hatching rate of different subgroups

Subgroup	Eggs with embryos + Eggs hatched	Eggs hatched	Hatching rate %	Khi-2	Value P	Sign<0,05 = *
A_1 NL 12 ; AL 12	670	545	81,34			
A_2 NL 12 ; AL 4	640	485	75,78	7,815	0,283	NS
B_1 NL 12 ; AL 0	585	445	76,07			
B_2 NL 12 ; AL 4	705	575	81,56			

NS: Not significant difference (P> 0.05)

3.6. Effect of photoperiod on mortality rate at start-up, growth and laying

No photoperiod treatment experienced a different mortality rate from the other during the start-up stage (chi-2 = 0.047, ddl = 1, p> 0.05).

The same is observed during the growth phase (chi-2 = 2.885, ddl = 3, p = 0.409) and the laying phase (chi-2 =

1.015, ddl = 3, p = 0.798) (table 11).

Table 11: Effect of photoperiod on mortality rate of different groups and subgroups at start-up, growth and laying

Breeding phases	Group and subgroup	Effective	Dead quail	Dead rate %	Kh-2	Value p	Sign<0,05 = *
Start up	A NL12 ; AL12	1480	88	5,95	0,047	0,827	NS
	B NL12 ; AL0	1480	72	4,86			
Growth	A_1 NL12 ; AL12	696	32	4,6	2,885	0,409	NS
	A_2 NL 12 ; AL 4	696	24	3,45			
	B_1 NL 12 ; AL 0	704	64	9,09			
	B_2 NL 12 ; AL 4	704	40	5,68			
laying	A_1 NL12 ; AL12	200	4	2	1,015	0,798	NS
	A_2 NL12 ; AL 4	200	0	0			
	B_1 NL12 ; AL 0	200	4	2			
	B_2 NL 12 ; AL 4	200	4	2			

NS: Not significant difference (P> 0.05)

4. Discussion

Photoperiod influences the weight growth of quail during the start-up phase. Lighting stimulates animals that consume during the night while those without lights sleep. The same observation is made at the growth phase. The A2 quail, which had the same start-up treatment and only 4 h of lighting, was lower in weight than the A1 subgroup. On the other hand, subgroup B2 seems to compensate for the effect induced at startup by a faster weight gain in the growth phase. This entire means that the application of artificial lighting has a positive impact on the growth of quail. The same observation has been made by [8] who have revealed the effect of photoperiod on quail weight increasing. [9,10,11] have also shown a beneficial effect on weight of poultry through intermittent lights. This has an impact on sexual maturity with an earlier laying age for A1 (33 days).

Feed consumption and weight gain were more pronounced among quail in subgroup A1, which received 12 hours of artificial light. This has shown a higher weight gain for these. These results corroborate those of [12] who showed a high weight gain in quails that consumed a large quantity of the feed. Although weight gain was greater for Group A animals, it was with group B animals that the best consumption indices were recorded. Thus, the animals of the subgroups B and more particularly the subgroup B1 without artificial light seem to have compensated for intake of additional feed induced by light and by subgroups A by a better efficiency of use of feed. In addition, effect of light on growth parameters seems to fade over time. Indeed, experimental animals have a substantially identical final live weight and despite differences in feed intake.

Egg weight is the most important parameter, not only for consumers, but also for egg producers [13]. In this experiment egg weight was influenced by photoperiod so that the heavier weights of eggs were observed in quail of A1 (10.32 g). These weights are relatively similar to those reported by [14] in laying quails at age of five months, by [15,16,17] in their control batches aged 7 to 20 weeks and by [18] in quails aged 08 weeks of age. Higher egg weights (11.80 g to 13.38 g) than those obtained within our experiment were observed by [19]. Indeed, the reduction of artificial light in A2 and the application of artificial light in B2 is a stressor factor that has adverse effects on the reproduction of quail [20]. [20] has cited several situations that can cause fear in birds, such as novelty, suddenness, environmental change, exposure to large open spaces or the presence of a predator.

Compared to the length and diameter of the eggs, numerous studies have been conducted. The photoperiod factor has shown that the animals subjected to a continuous light time had a higher mean diameter than those of the other subgroups. The quail used for the experiment all recorded similar egg lengths during the laying phase between the different subgroups of the study. The photoperiod had no influence on the length of the eggs. Other parameters may nevertheless affect the length of the eggs. Indeed, [21], then [22] have shown the influence of the feed factor on the length and width of eggs.

Subgroup A1 had the highest rate of laying compared to other flocks during the first two weeks. This could be explained by the fact that the A1 birds had early sexual maturity; they started laying earlier (33 days of age) compared to the other subgroups (35, 40 and 39 days of age respectively for A2, B1 and B2). But after two weeks, production was virtually similar between the four subgroups of the study. This catch-up is due to the fact that the majority of quails have reached sexual maturity and the photoperiod does not influence the laying phase. These results are consistent with those of [23] who have reported that commercial egg production increased with the lighting hours during the rearing period. [24] also showed the effect of a light program change on the laying performance of two layer strains. According to [25,26,27], the use of a continuous lighting of 18 hours causes a fall of the production in comparison with the short hours of light. According to them, this reduction is due to the stressful effect of the long period of light. These results are also supported by [28] who recorded a significant reduction in egg production between (16L: 8O) and (18L: 6O) in favor of (16L: 8O).

The different subgroups of quails constituted did not show any difference in the fertility rate and the hatching rate. The photoperiod would therefore have no influence on these parameters as well as the mortality rate. These results corroborate those of [29] for the reproductive sex ratio factor (Male / female) and differ for the cage system factor on quail egg fertility. As for [30], they found significant difference only for temperature variations on the quail egg hatch rate.

5. Conclusion

At the end of this work, it appears that the increase in the photoperiod has a positive influence on parameters such as weight gain, weight and egg diameter. For these parameters the best results are obtained with the quails of subgroup A1 (NL12, AL12). In general, however, egg length, mortality, oviposition rate, quail fertility and hatch rate were not influenced by photoperiod. In view of all these results, the application of artificial light of 12 hours in addition to daylight could be recommended in quail breeding.

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