



## Effects of Light Intensity and Photoperiod on growth and reproductive performance of *Coturnix japonica*: A review

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### ABSTRACT

Present review was performed in order to understand the influence of photoperiod and light intensity on *Coturnix japonica*. Different literatures were reviewed regarding egg production, behaviour, body weight, feed intake, feed conversion ratio, carcass weight, egg quality with respect to photoperiods and intensities. It was noticed from the reviewed studies that light intensity of 80 and 20 luxes for 8 hours during growing period and 240 and 60 luxes for 16 hours during laying period results 194.85±4.46, 191.42±2.87 feed intake, 201.00±13.82, 210±15.1 weekly weight gain. The better feed conversion ratio remains (1.03) with light intensity of 80 and 20 luxes for 8 hours during growing period. Carcass weight remains as 98.33±8.33 and 99.56±5.44, dressing percentage 50.46% and 52.01%, egg production percent 50.11 and 48.81, egg length 32.15±0.54 and 32.12±0.35, egg width 24.87±0.22 and 23.75±0.31, egg weight 9±0.44 and 9±0.54, 11.2±0.73 when light intensity of 80 and 20 luxes for 8 hours during growing period and 240 and 60 luxes for 16 hours during laying period is provided. In conclusion *Coturnix japonica* raised on 80 luxes for 08 hours light intensity during growing period and 240 luxes for 16 hours light intensity in laying period results better FCR and feed intake in cage system. While *Coturnix japonica* reared with 5 luxes for 16 hours photoperiod during growing period and 15 luxes for 20 hours photoperiod in laying period demonstrate better egg production and behaviour.

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## Introduction

*Coturnix japonica* are small sized game birds. They are globally reared on commercial scale for egg and meat production. They have ability of achieving sexual maturity at the age of 5 to 6 weeks. Two species of *Coturnix japonica* have been most popular for breeding including Japanese quail and the American quails. *Coturnix japonica* is classified under family Phasianidae. These small birds can migrate between Europe and Asia, thus also called migratory birds (Faitarone et al., 2005). The *Coturnix japonica* possess several favorable traits including rapid sexual maturity, higher growth rate, higher egg production (300 eggs per Year), small space requirement, smaller generation interval, lower feeding needs, less feed cost, short incubation period, lesser susceptibility to diseases (Jatoi et al., 2013). Being a smallest member of poultry and possession of above said characteristics, *Coturnix japonica* are nowadays widely used for eggs and meat production on commercial scale. In addition to that farming of these fascinating birds need low capital investment compared to other poultry species (Minvielle, 2004). *Coturnix japonica* has got much economic importance during last decade due to higher production rate of eggs and meat. These game birds are liked

for their unique flavor and taste. In fact current survey shows that quail are found about in all continents. Numerous lines, breeds and varieties have been discovered for different production purposes (Maiorano et al., 2012).

The transition of backyard to commercial poultry production has resulted rearing of *Coturnix japonica* in large barns or brooder houses which require intensive management and to facilitate the production, *Coturnix japonica* producers are manipulating and modulating environmental parameters such as temperature, humidity, ventilation, gases, light intensity, light duration and light color (Ojedapo et al., 2014). From these all factors, light is assumed to be the most critical factor for *Coturnix japonica* farming. Light not only controls many physiological and behavioral processes of bird but it has vital impact on production efficiency, behavior, egg production, and health of *Coturnix japonica* (Olanrewaju et al., 2006). Thus, practice of artificial lighting is most common for increasing reproductive activity of laying females. The physiological action of light happens when it contact with eyes and converted into nerve impulses that are sent to the brain. The brain then coordinates the stimulus for influencing the pituitary gland to secrete the necessary hormones for

ovulation (Lewis and Morris, 2000). The impact of light on *Coturnix japonica* physiology, behavior, performance and reproductive activity is largely due to three factors such as intensity, photoperiod and wavelength. The knowledge in this regards is well documented in the literatures (Kuhles and Petersen, 2005). Thus, current review was planned to investigate the significance of photoperiod and light intensity for *Coturnix japonica* and to explore possible effects of different types of light regimes on *Coturnix japonica*.

### *Coturnix japonica*

*Coturnix japonica* is concerned to the family Phasianidae and order Galliformes. It is the largest group of birds with diverse characteristics compared to other poultry birds. Phasianidae family is much difficult to divide into natural groups because of several diverse features. However, 3 subfamilies have been classified including *Perdicinae*, *Odontophorinae* and *Phasianinae* (Shanaway, 1994). Among different breeds, *Coturnix japonica* has major research concern due to unique features such as smaller generation interval, easy maintenance, fast growth rate and higher production of eggs (Tarhyela et al., 2012). These unique characteristics have resulted *Coturnix japonica*, the bird of choice for commercialization and scientific research worldwide. Studies concerned to egg production and growth performance of *Coturnix japonica* have been well documented (Vali et al., 2005; Minvielle and Oguz, 2002). Female birds become matures at the age of 6 weeks and start laying eggs within approximately 7 weeks of age. These small birds can produce 4 generations in a year and that makes them most suitable and effective poultry bird on commercial scale (Onyewuchi et al., 2013). Female birds attain live body weight ranging from 120 to 160g at maturity, however males range from 110 to 140g (Figure 1). The egg weight (average) remains 10g, while newly hatched has been reported 7g (Figure 2). They lay their eggs mostly at evening time. Eggs' incubation period ranges from 17 to 18days (Saidu et al., 2014). The eggs of *Coturnix japonica* are popular due to their unique color and mottles and preferred by consumers throughout Easter (Figure 3). They may be valuable supplements due to high quality products for human. The eggs have lower fat content compared to chicken eggs, while the cholesterol levels remain similar. Eggs are richer in essential amino acids and minerals than the chicken eggs (Tolik et al., 2014).

### Effect of photoperiod and light intensity on feed intake, weight gain and feed conversion ratio of *Coturnix japonica*

The variety of light regimes are applied for attaining maximum performance from *Coturnix japonica*. Favorable results were recorded with light duration of 24 hours or 23hours and 1hour dark period (Pieter et al., 2013). In a study, researchers examined the influence of five different lighting regimes and stated that carcass weight declines with decrease of photoperiod. The effect is more influential in female *Coturnix japonica* compared to males (Watkin et al., 2014). Higher body weight gain rates in birds may be to less energy expenditure and better feed intake by the birds. The interaction among energy intake and expenditure significantly affects the overall performance of birds

particularly body weight gain (Farzinpour et al., 2013). Overall body weight gain increases by modulating the light duration and consequently decreasing dark period for birds to improve intake. It is evident that consequences of food activity depends upon the photoperiod. More light duration simultaneously results more intake of feed, less feeding duration and balance digestion which ultimately results maximum weight gain of birds (Hassan, 2013). Light regimes restriction in *Coturnix japonica* improves performance by decreasing physical activity and save energy expenditure. A light period of 08 hours in *Coturnix japonica* furnishes the best body weight Table 1 (Imelda et al., 2016).



Figure 1. Male (right sided) and female (left sided) *Coturnix japonica*



Figure 2. Newly hatched chick of *Coturnix japonica*



Figure 3. Eggs of *Coturnix japonica* having spots on shell as characteristic feature

Table 1. Performance of *Coturnix japonica* at different light durations

SN	Light duration	Influence on performance
1	8 hours/day	Higher body weight
2	12 hours/day	Consume lower quantity of feed
3	20 hours/day	Highest feed intake
4	15 hours/day	Increased eggs production
5	Lower than 15 hours/day	Less eggs production/cessation of laying

Feed intake of *Coturnix japonica* is significantly affected by light type and its duration provided to birds (Table 1). Birds with 12hours light duration consume lower quantity of feed. However highest feed intake is seen when longer light duration (20hours) is provided. It may be argued that artificial lighting might increase the stress condition and in response to that birds consume large quantity of feed (Jatoi et al., 2013). It has also been reported that the light sufficiently affect poultry house round the clock. (Khalil et al., 2014). The reproductive performance of birds is considerably influenced by light duration and intensity. Change in growth of *Coturnix japonica* was recorded in contrast to light intensity and duration (Lucian et al., 2012). Light duration has been proved to be major welfare aspects for the rearing of poultry birds. Light with duration more than 15hours/day increase eggs production, while less duration (lower than 15hours) cause less eggs production and cessation of laying as shown in the Table 1 (Fairchild, 2007). Duration of light supply in the poultry house significantly improved the reproductive performance and production of the *Coturnix japonica* (Mase and Oishi, 2013). Further feed conversion efficiency as the index of body mass considerably influenced by illumination. Improvement in feed conversion efficiency is noticed when light duration remains shorter as well as longer (Nunes et al., 2014; Omer et al., 2015).

#### Effect of photoperiod and light intensity on reproductive parameters of *Coturnix japonica*

Among environmental factors light is of utmost importance *Coturnix japonica*. This factors influences the reproductive activities, behavior, performance, production and overall health of laying females. Thus, artificial lighting with different light duration and intensity is widely used for increasing performance of laying females in the houses (Rozenboim et al., 1998). Light has been reported as main influencing factor for several physiological processes in the birds. Egg production and quality is highly affected by light source, light intensity, light duration and light color. The influence of light intensity (LI) on laying hens has been critically studied with special focus on age at first egg and egg production rate. Light intensity lower than 4 luxes delays the sexual maturity of females raised under cage system (Nicholls et al., 1988). In another study, dose related increase in egg production of hens in three tiered cages (LI of 0.2, 1 and 5 luxes 44) was measured. Birds were managed on 0.2 luxes laid eggs at 9 to 12 days later compared to birds raised on 1 and 5 luxes. Diverse light spectrums have been reported to influence the birds'

growth, behavior and production (Sultana et al., 2013), thus understanding the influence of several types of light on poultry birds utmost important for growing industry. Light emitting diodes (LEDs) is considered as most superior to other lights sources in terms of durability, energy savings, and longevity (Benson et al., 2013). Multiple factors essentially be taken into account when evaluating cage lighting system like light period, light spectrum, and light intensity. Among all aspect of bird lighting, light period is most probably studied because it is assumed to be very important for proper management of *Coturnix japonica* and can increase growth efficiency in *Coturnix japonica*. Light spectrum is actually the combination various electromagnetic radiation with different wavelengths which are emitted from light source. The visual range of poultry and other animals is different. The most striking fact is the inclusion of ultraviolet light, which have diverse range due to addition of 4<sup>th</sup> type of photoreceptor (Osorio et al., 1999). Supplemental addition of UV light has been reported to increase sexual activities, mating behavior, egg output and behavior compared to control birds with normal lighting fluorescent of Forty Five lights (Jones et al., 2001). The use of artificial lighting for inducing laying potency of females has been considered as the most important contribution for the improving egg production of *Coturnix japonica* (Shanaway, 1994). Light duration of 14 to 18 hours/day is assumed to be very important for *Coturnix japonica* for maintaining peak production of eggs and fertility. Supplementary light is essential in the winter, autumn and spring months for maintaining the reproductive activities and production *Coturnix japonica* (Randall and Bolla, 2008). Freitas et al. (2005) studied the influence of intermittent lighting, natural lighting, one day increasing lighting and continuous lighting on performance of *Coturnix japonica* during end of laying cycle. Researches show that 5.38 lux light intensity is assumed to be optimum for maximum egg production in dark houses for layers (Skouglund et al., 1975). Recent researches show that 10 lux is needed at cage or bird's head height in open-sided houses. Wild *Coturnix japonica* have been reported to lay 7 to 14 eggs/Year. On other hand domestic *Coturnix japonica* can lay approximately 280 eggs in a Year (Puigserver et al., 2007).

In *Coturnix japonica* of subtropical and temperate latitudes, photoperiod (gradual/abrupt) increase initiates the gonad recrudescence and laying activity. Reduction in day length (short photoperiod) delayed the onset of sexual maturity and even terminated egg laying in the birds (Yadav and Chaturvedi, 2015). The wavelength of light influenced the egg components, shell quality and overall egg production of the laying hens. Application of longer photoperiod favored egg production in cage system. A reduction in light duration resulted reduced eggs production and laying sequence length (Zawilska et al., 2015). Light type, intensity and duration significantly influenced the birds' health. No improvement was recorded with the use of high intensity, light during and short day light restriction on subsequence reproductive efficiency. Percentage of eggs/hen/day was prominently decreased by photoperiods of 23 to 26 weeks and 31 to 34 weeks. This reduction photoperiod caused considerably impact on hen day egg production percent. In addition to

sexual maturity, light has also been reported to affect egg production in many avian species (Watkins, 2014).

## Conclusions and Recommendations

In conclusion *Coturnix japonica* reared under cage system with 80 luxes for 8 hours light intensity during growing period and 240 luxes for 16 hours light intensity in laying period show better FCR and feed intake, while *Coturnix japonica* reared with 5 luxes for 16 hours photoperiod during growing period and 15 luxes for 20 hours photoperiod in laying period demonstrate better egg production. In view of the present review findings, it is recommended that *Coturnix japonica* must be housed under photoperiod of 5 luxes for 16 hours duration during laying period for getting maximum egg production as well as hen day egg production. Further studies concerned to influence of photoperiod and light intensity should be conducted on biochemical and production parameters of other poultry birds for better understanding and improving the breed production.

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