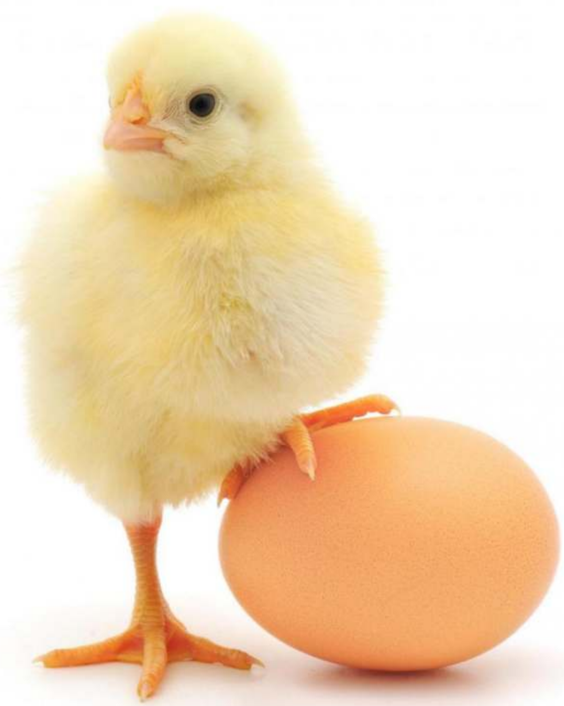
ISSN 1682-8356
ansinet.org/ijps



INTERNATIONAL JOURNAL OF POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 14 (12): 657-663, 2015
ISSN 1682-8356

Effect of Photoperiod on the Production of Chukar Partridges (*Alectoris chukar*)

V.I.A. Alva[1], L.J.A. Quintana[1], I.C. Gonzales-Rebeles[1] and A.M. Gonzalez[2]
[1]Departamentos de Medicina zootecnia de Aves, Etologia, Fauna Silvestre y Animales de Laboratorio, FMVZ, UNAM, Circuito Exterior, Ciudad Universitaria, Delegacion Coyoacan, D.F.C.P. 04510, Mexico,
[2]Departamento de Zootecnia, Posgrado en Produccion Animal, Universidad Autonoma Chapingo, Km 38.5 carretera Mexico-Texcoco, C.P. 56230, Chapingo, Estado de Mexico

Abstract: This study evaluated the effect of variations in photoperiod duration on production indicators such as amount of eggs-laid and weight in chukar partridges (*Alectoris chukar*). Ninety individuals were divided into groups of 3 males and 7 females per cage (9 cages). Three different photoperiod treatments were used (18, 16 and 14 h light) with three repetitions per treatment. Males and females were randomly selected for each group. Means between treatments were compared using ANDEVA with Tukey's multiple comparisons in a GLM using the SAS V.8.0 software package. The following variables were evaluated during 18 production weeks: egg weight (EW), egg mass (EM), eggs per female (EF) and laying percentage (LP). Significant differences ($p<0.05$) were found in EW between 18 and 14 h light, representing a 7.1% in EW with decreasing photoperiod. No significant differences ($p>0.05$) were found in the remaining parameters between treatments. There was an improvement of all production variables at the smallest photoperiod (14 h) even though only EW was statistically significant.

Key words: Partridges, photoperiod, light-hours, egg production, laying cycle

INTRODUCTION

Partridges belong to the *Galliformes* order in the *Phasianidae* family with distribution in Asia and Mexico (Del Hoyo *et al*., 1994). Farmed species commonly include the grey partridge (*Perdix perdix*), Greek partridge (*Alectoris graeca*), chukar partridge (*Alectoris chukar*) and red partridge (*Alectoris rufa*).

Currently there has been increased interest in partridge production as a branch of modern poultry farming, with high economic possibilities and great marketing perspectives (Agustin, 1992). The grey and red partridges are the ones farmed mainly. They offer three production possibilities that are meat, eggs and reintroduction into fields in areas where they have become extinct (Martinez *et al*., 2005). There are meat-producing farms that finish Greek chukar partridges, which are partridges that reach higher weights at slaughter (between 500 and 600 g) (Gorrachategui, 1996).

These characteristics have allowed the production and commercial exploitation of these animal species, together with the fact that their eggs have low cholesterol content, around 13 (Nath and Mark, 1976) to 13.92 mg/g in intensive systems, 13.83 mg/g in backyard-type systems and 12.89 mg/g in organic systems (Krawczyk, 2009). This is similar to poultry whose eggs contain around 14.0 mg/g of egg yolk. Partridge meat has the following parameters: 55.9 to 62.4% proteins, 22.2 to 29.1% fat, 1.6 to 5.6% ashes, 1.4 to 1.2% cholesterol about 70-243 mg/100 g cholesterol in meat and a 74.4% carcass performance. Together these performance variables demonstrate a good production potential for this species (Gaglianone *et al*., 2006).

Partridges are monogamous (Quintana, 2011). Their eggs weigh between 18 and 20 g. Their typical coloring is creamy with somewhat dark maroon markings that in their natural environment provide them with camouflage (Agustin, 1992). In general, these are medium-sized birds (32-39 cm) with the female larger than the male; they have a long neck and very short tail with no sexual dimorphism (Gomez de Silva, 2005). Lifespan can reach up to 15 years 3 months (USGS Longevity Record cited by Wilson and Ceballos, 1993, the birds of Mexico city 2° Edición). Plumage pattern is similar for both genders. A dark line extends through the forehead, eyes and neck; their throat is white with grey head and breast. The flanks are black with external feathers of the tail dark brown; the eyelid edges, feet and fingers are pink to red in color (Office, 1994). Adult males weigh between 420 and 530 g, while females weigh between 350 to 450 g. In order to reproduce birds must reach between 320 to 350 g (Quintana, 2011) and when adults their weight must be around 400 g for females and 450 g in juvenile males. Irregular weights may indicate disease and low quality of partridges (Agustin, 1992).

The reproductive season extends from January until July according to Perez and Perez (1981). Mating occurs in the spring and summer (Gomez de Silva *et al*., 2005),

Corresponding Author: L.J.A. Quintana, Departamentos de: Medicina zootecnia de Aves, Etologia, Fauna Silvestre y Animales de Laboratorio, FMVZ, UNAM, Circuito Exterior, Ciudad Universitaria, Delegacion Coyoacan, D.F.C.P. 04510, Mexico

egg laying between January and February or earlier under artificial lighting (Gorrachategui, 1996). Clutch size is 6 to 20 eggs that are 43 mm in length and weigh between 23 to 24 g, which are smooth and shiny, yellowish white and have markings that are brownish-grey to brown (Gomez de Silva *et al.*, 2005; Office, 1994). Incubation lasts between 22 and 24 days (Gomez de Silva *et al.*, 2005; Quintana, 2011; Ehrlich *et al.*, 1988) and the eggs should be constantly moved at least every three hours (Quintana, 2011). Eggs should be kept at a temperature between 10 to 13°C with a maximum relative humidity of 60-75% (Perez and Perez, 1981), although incubation must be done at 39.5 to 39.1°C with 80 to 90% humidity. Chicks are born weighing between 29 to 37 g (Martinez *et al.*, 2005). Feeding is generally based on grains such as corn, sorghum, wheat and barley. Birds eat approximately 30 g a day (Quintana, 2011).

It has been estimated that a female lays on average 35 to 40 eggs per season at a rate of one every 35-48 h (Perez and Perez, 1981). It is possible to induce earlier laying by 3 to 4 weeks, increasing clutch size by 12 hatchable eggs using artificial lighting. It is possible to obtain 30-35 eggs during the first year and 60 in the second year combining artificial and natural lighting, (Gorrachategui, 1996).

The purpose of rearing wild birds as meat and egg producing animals is to incorporate a new source of proteins for human consumption and provide other profitable possibilities (Martinez *et al.*, 2005). These possibilities include repopulation and production of hunting species in country estates and intensive commercial exploitation of individuals that have good laying aptitude and growth speed (Gonzalez, 1997). By the end of the 70's, there were 40 country estates, mainly with partridges and since then rearing techniques have improved greatly increasing production (Cepero, 2009).

Photoperiod has been defined as the amount of light-hours (natural and artificial) that birds receive every 24 h (Quintana, 2011). Programs vary the quantity of light according to the season and latitude of the establishment (Leonard *et al.*, 2003; Ruiz, 1992). Intermittent and ahemeral lighting are two types of lighting programs that are used in farming. Intermittent lighting programs have more than one light and dark period every 24 h, while ahemeral lighting has light-dark cycles that add to more than 24 h/cycle (Hevia and Quiles, 2005). These programs are used since light stimulates the procreation function in animals by favoring the transformation of provitamin D into vitamin D, which is important in bone formation and steroid manufacturing in the body. Furthermore, this vitamin acts as a virilization factor in animals (from a sexual point of view) given the hormonal richness present in their body (Perez and Perez, 1981).

Photoperiod manipulation has an effect on domestic fowl, influencing the initiation of sexual activity, helping the start of laying and its synchronization, egg size and shell quality (Robinson and Renema, 1999; Morris, 1964; Kirby and Froman, 2000). It also improves body and genital development (Robinson and Renema, 1999) and light plays an important role in the various phases of laying hens (Lera, 2005).

It is known that light duration in every 24-h period has an effect of egg laying in hens (Ryan *et al.*, 1959; Lowe and Heywang, 1964). Other studies have shown the response of domestic fowl to ahemeral lighting regimes (Foster, 1968; Rosales *et al.*, 1968). In this case, 14 to 16 light-hours have been recommended for poultry with a minimum of 10.8 lux intensity (Lucas *et al.*, 1967). Photoperiod also affects wild fowl as found by Ostrander and Turner (1961), as well as Morris (1967a, b) who studied the effect of light intensity on reproductive parameters.

Slaugh *et al.* (1992) compared two groups exposed during 8 weeks to differing light regimes. The first were exposed to an increase in natural lighting at 11.3L:12.5D, while the second was exposed to 8L:16D, afterward both were taken to 14L:10D (where L is light and D is darkness). These authors report that group one started laying 3 weeks after group 2, although both reached 100% egg-production at 41 days and group 1 showed higher production percentage at the beginning of the cycle, while group 2 had higher production at the end of the cycle. Both had stable production curves between days 31 to 41.

Regarding egg production (laying percentage) Mehmet and Ozbey (2008) mention that a group of caged birds subjected to a 16 light-hour photoperiod showed 49.43 average egg production, 39.87% egg production (laying %) and 20.57 g average egg weight; the latter in agreement with Yannakopoulus (1992) findings of 20.84 g egg-weight. Furthermore, Cetin (2002) using three groups of birds (1 male with 3, 4 or 5 females, respectively) under natural conditions obtained production percentages of 40.53, 48.79 and 44.85 respectively. It is also known that photoperiod has an effect on sexual maturation and gonad development (Woodard *et al.*, 1978, 1986).

There has been a recent increase in demand of partridges for various uses such as food, ornamental birds and for hunting estates. As such, alternative poultry farming has become important for the production of eggs and meat that are different from staple products. High quality products are produced in a more "natural" and traditional way in tune with animal welfare and "sustainable" agriculture, as compared to intensive poultry farming, all the while needing relatively modest investment as their products provide greater economic benefits (Cepero, 2009).

Studies published on the effects of photoperiod on the production parameters of partridges are few and not recent. It is important to ascertain the necessary parameters for the correct production handling of this species. The purpose of this study was to determine if variations in photoperiod during their productive cycle provide better productive performance in terms of egg production and weight.

Our hypothesis was that the increase in photoperiod (light-hours) would improve productive parameters in terms of eggs laid per female (egg production), egg mass, laying percentage and egg weight in chukar partridges, similar to what occurs in domestic fowl.

Study site: The study was carried out in "Centro Reproductor de Vida Silvestre SMRN Flor del Bosque, SEMARNAT", in the Ecological Park in the State of Puebla Mexico. The main purposes of this center are the reproduction of these species, to carry out donations of birds and provide environmental education to the public. The park has a surface of 664.03 ha with varying heights from a low of 2200 to a maximum of 2470 momsl. It is located between 19°00'00 and 19°01'50 latitude north and 98°20'35 and 98°20'53 longitude west (Martinez, 2008). The climate is temperate with rains during summer and an annual temperature of 16-18°C and average annual rainfall of 750-950 mm (Martinez, 2008). The breeding house is located at 2225 momsl, measures 45 m^2 and is composed of 30 pens divided by a central hallway with a gable roof. Each pen measures 3 m long by 2 m wide and 2 m high, with brick and wire divisions; the floor is gravel. Each pen has hopper-type food and water supplies and a nest area delimited by bricks. Pheasant production uses nine pens and partridge production uses nine pens. The breeding house has chukar partridges (*Alectoris chukar*), the subjects of this study, as well as common pheasants (*Phasianus colchicus*), golden pheasants (*Chrisolophus pictus*), Lady Amherst's pheasants (*Chrisolophus amherstiae*), Silver pheasants (*Lophura nycthemera*) and melanistic mutant pheasant (*Melanistis mutantis*). Furthermore, the breeding house has three areas, breeder house, rearing house and incubation area, as well as flight area.

MATERIALS AND METHODS

Ninety chukar partridges were used (63 female and 27 male) weighing between 546g and 601 g with ages between 1 and 2 years. The study lasted for 18 weeks between March 2nd and July 5th, 2009. Before the start of the lighting regime, birds were divided into three groups and kept in the breeders' area. Three lighting regimes were used, with individual sections separated by black curtains. The schedule varied according to the latitude and season. The control group was subjected to 18L: 6D (18 h light with artificial lighting from 6 to 12 pm: 6 h darkness); the second group was subjected to 16L: 8D (with artificial lighting from 6 to 10 pm) and the third group to 14L: 10D (with artificial lighting from 6 to 8 pm). Light bulbs used in the light fixtures were 75-watt white light.

The experiment ran with three repetitions per group. Groups were formed by three males and seven females, placed in pens with gravel floor and hopper-type food and water supplies. Commercial balanced feed was provided in pellet or meal form with a minimum 18% raw protein content and every other day selected grain was provided (such as corn) as well as green alfalfa as means of enrichment.

Eggs were collected daily, three times a day, every 4 h and placed on plastic trays, vertically, thin side down, disinfected using a 1:10 antibenzil water solution and kept for one week in the incubation room. Later they were incubated for 23-24 days. Eggs obtained from each group were marked and weighed once a week using an electronic scale. Daily counts were recorded.

Productive behavior of the birds was evaluated through the weekly parameters: egg weight (EW, g), egg mass (EM, g), number of eggs laid (EL) and laying percentage (LP, %). The accumulated values for 18 weeks were also obtained. Egg mass was obtained by multiplying egg production times egg weight and divided by the number of laying females. The laying percentage was obtained by dividing the total production by 28 (number of females times 7 days) and multiplying by 100.

Bird distribution experimental design was fully random among the three treatments or photoperiods. Data was analyzed using a random statistical method described as $Y_{ijk} = \mu_{ij}+S_i+T_j+S_i*T_j+E_{ijk}$, where Y_{ijk} are the response variables evaluated, μ is the mean of the I experimental weeks and j treatments, T are the treatments or photoperiods j, S are the I experimental weeks, T_j*S_i is the interaction of treatment j with week I and E_{ijk} is the experimental error of week I in treatment j of repetition k. Furthermore, an ANDEVA test was used as well as Tukey's multiple comparisons. Both means comparisons were carried out with the SAS V.8.0 software package under the general linear models (GLM) procedures.

RESULTS

The photoperiods were implemented during the week between February 13 and 20th, 2009. Parameters were recorded between March 2 and July 5, 2009 (18 weeks) although production started on February 28 and ended on August 9 (22-week total egg-laying period). Table 1 shows the weekly response of the various egg-production variables in chukar partridges subjected to the three photoperiods throughout the 18-week study period. Only EW showed a significant photoperiod effect ($p<0.05$). As light-hours decreased, in the range under study, EW increased ($p<0.05$); decreasing from 18 to 14 h light was associated with a 7.1% increase in EW. No other statistically significant differences ($p>0.05$) were found between treatments among the evaluated variables.

Table 1: Response of egg production variables (weekly averages) in Chukar partridges subjected to 3 photoperiods for 18 production weeks

	------------ Photoperiod ------------			---- Significance ---	
Variable[2]	18h-l	16h-l	14h-l	Photo	Week
EW (g)	21.96^{b}	22.89^{ab}	23.52^{a}	*	NS
	SE	0.22	0.14	0.41	
	Total	21.30	22.74	23.14	
EF (pieces)	2.38^{a}	2.44^{a}	2.60^{a}	NS	**
	SE	0.12	0.15	0.14	
	Total	38.14	39.04	41.69	
LP (%)	34.05^{a}	34.86^{a}	37.16^{a}	NS	**
	SE	1.84	2.23	2.09	
	Total	30.27	30.99	33.03	
EM (g)	52.87^{a}	56.98^{a}	61.54^{a}	NS	**
	SE	2.97	3.64	3.30	
	Total	810.8	892.7	964.2	

[a,b]Variables with different letter are statistically different (*$p<0.05$) (Tukey's multiple comparison)

[1]Photoperiods: Control: 18 h light, experimental (1) 16 h light and experimental (2) 14 h light

[2]EW: Egg weight, EF: Eggs per female, LP: Laying percentage, EM: Egg mass, SE: Standard error

Total: Total accumulated result per female during the 18 weeks

[3]Significant: *$p<0.05$, **$p<0.01$, NS (Not Significant) $p>0.05$

Nevertheless, the photoperiod throughout the laying cycle had an effect on LP, EF and EM, with differences in the three photoperiods depending on the experimental week ($p<0.01$). Experimental weeks, which represent time throughout the laying cycle, had an effect on all variables evaluated with the exception of EW; in other words the differences in EW were maintained between the three photoperiods ($p>0.05$).

DISCUSSION

Perez and Perez (1981) mentioned that the reproductive season or time starts at the end of January and lasts until July, while Gorrachategui (1996) stated that the laying period occurs between January and February and Gomez de Silva (2005) established that the breeding season encompasses spring and summer. The present study found that it started at the end of February and lasted until August. This could be due to the fact that the laying and reproductive period depend on the northern latitude at which birds are located, as well as the fact that it is known that artificial lighting causes the laying cycle to come earlier (Gorrachategui, 1996).

Comparing with the 14 h-light photoperiod increasing or giving excess of day light affects the reproductive behavior reducing egg production; likewise, Woodard *et al*. (1986) had a higher production with 8 h-light during 6 and 8 weeks light conditioning. Their production was at 8 h, 12 more eggs than at 16 h; at 14 h, 2.65 more eggs than at 16 h and 3.55 more eggs when comparing 14 h with 18 h. In the experiment carried out by Woodard *et al.* (1986) they used 50 lux and 0.1 lux and the birds were conditioned at 6 and 8 weeks. In contrast, in this study, birds were conditioned only for 2 weeks before the start of the lighting period modification and the minimum hours light were 14 compared to 8 h, a difference of 6 h more.

Previous reports have established mean production performances of 35-40 eggs (Perez and Perez, 1981) and 30-53 eggs (Gorrachategui, 1996) the first year. This study found similar, albeit higher, results with an average production for each treatment (14, 16 and 18 h light) of 41.69, 39.04 and 38.14 eggs, respectively, showing a decrease in the longer 2 photoperiods.

It is therefore possible that an increase or excess light per day has a negative impact on reproductive performance decreasing egg production. Partridges become refractory with long light days, an effect that was observed in this study, since when hours of light increased (18 h-l) all parameters measured decreased, even though it was only statistically significant for EW.

Office (1994) stated that at 16 h they obtained more egg production. But this is not in agreement with what was found in this study, since when comparing the 16 h group with the other two, improvements could be seen in the 14 h group (2.65 more eggs than the 16 h group), likewise, when compared to the 18 h group production performance was improved (3.55 more eggs than the 18 h group).

Regarding egg mass, this parameter becomes affected as birds age since egg laying pause periods increase tending to produce low-weight eggs (Cabezas-Diaz *et al*., 2005). The essence of this process implies the intervention of hormonal changes that could have an effect on the reduction of egg mass in birds subjected to 16 and 18 h photoperiods. This would need to be researched to confirm.

Young females tend to start laying later in the season than more mature females, possibly due to a low response to stimulation of the reproductive system causing a delay in gametogenesis and steroidogenesis. It has been suggested that physiological changes in the laying sequence varies with age. Experienced females are better than females with no previous experience since they lay eggs earlier, eggs weigh more and they produce more chicks than first-timers. For example, Cabezas-Diaz *et al*. (2005) obtained 824 eggs from females older than 3 years, in three cycles.

Egg mass increases with clutch size (pauses), throughout the laying sequence, depending on female age. Variation in egg size within these pauses is controlled by physiological changes that be adaptive, or not, in this species. This study showed that egg mass is affected by the photoperiod resulting in 964.2, 892.7 and 810.8 g (at 14, 16 and 18 h, respectively). It is clear that increasing light to 18 h has a similar effect in terms of decreased egg mass, possibly due to a low response obtained from the female's reproductive system. The effect of breeder age was minimized in this study by restricting the age of breeders to one to 2 years of age (already mature).

Regarding production % (egg laying), Cetin (2002) reported that in their 3 experimental groups, using natural light, they obtained 40.53, 48.79 and 44.85% production, while this study obtained 37.16, 34.86 and 34.05% production (at 14, 16 and 18 h, respectively). This reduction in performance could be due to the number of birds used in each group and the duration of the study, although at the largest photoperiod (18 h) both studies had decreased performance.

Significant differences were found regarding average size and weight of eggs between the three photoperiods 23.52, 22.89 and 21.96 g at 14, 16 and 18 h, respectively due to the excess light which changed the physiology of females and the amount of estradiol causing them to be photorefractive, that is to say rejecting light as reproductive stimulant. This is similar to the results of Siopes and Wilson (1981) since they suggest that when decreasing light intensity, females end their photorefraction allowing their productive cycle to initiate. Furthermore, Office (1994) stated that egg weight ranges between 23 to 24 g and Yannakopoulos (1992) found that eggs weighed 20.84 g. Eggs weighed in the present study were 22.89 and 21.96 g at 16 and 18 h, respectively, which is slightly less than the report by Office (1994), but are within the average stated by Yannakopoulus (1992). Likewise, decreased photoperiod improves egg weight, especially significant in the 14 hr. group as eggs weighed on average 23.53 g. Woodard *et al*. (1986) obtained improved egg weight in the 16 h group when compared to the 18 h group and when compared with this study, the 14 h group had better weight than the 16 h group and better weight than the 18 h group.

Likewise, Mehmet and Ozbey (2008) reported that groups caged with less amount of light, with photoperiods of 14, 16 and 18 h showed an average of 49.43 eggs, 39.87% egg production (laying %) and 20.57 g egg weight, which are compared to the corresponding 39.62, 35.35% and 22.79 g that resulted in this study.

Perez and Perez (1981) pointed out that eggs from the first laying sequence are larger than eggs of the latter sequence (have higher weight). Such trend was not observed in this study, since weight increased at weeks 4, 9, 15, 17 and 18 among all treatments, with an increasing trend towards the end, averaging 23.5 g in weight.

In agreement with Woodard *et al*. (1978), birds during the second cycle (full light conditioning at 66 weeks and not at 40 weeks) showed higher egg production. Greater egg production was achieved at weeks 12, 10 and 7 averaging 24.66, 21.66 and 25.33 eggs at 18 h-l, 16 h-l and 14 h-l treatments, respectively. This relates to age as, due to unknown factors, photosensitivity decreases with increasing age.

It is noteworthy to mention that Woodard *et al*. (1978, 1986) conditioned birds with a maximum of 8 weeks of light, whereas in this study birds were subject to the full 22 weeks of light, which could have a negative effect on birds subjected to the greater light quantity (18 h-l).

Previous studies have shown that males also need to be photostimulated at shorter length days as females, so that males can be synchronized at days' length with gradual natural increase (sudden artificial increase to 14 hr. during the first part of February) (Slaugh *et al*., 1992). Nevertheless, in this study, both genders started their photostimulation at the same time and that effect was not observed.

The results obtained in this study were not those expected in terms of the three photoperiods, since it was expected that greater photoperiods (18 h) would result in better reproductive performance and greater egg production, similar to what happens in commercial poultry. However, the results suggest that it is better to give them less hours light in order to obtain better productive performances. The 14 h photoperiod favored better performance regarding EF, EM, LP and EW, even though there was no statistical difference on EW among treatments, while the 18 h treatment reduced all parameters measured.

Conclusion: As such, the conclusion is that this species is different from domestic fowl, since they respond unequally to stimulation by light and to the latitude at which they are located as reproductive parameters improve with less hours light (14 h) and worsen with increased hours light (18 h).

ACKNOWLEDGEMENTS

We thank the support provided by SMRN of the State of Puebla and the services of the facilities in the UMA "Centro Reproductor de Vida Silvestre SMRN Flor del Bosque, SEMARNAT" located in the Lazaro Cardenas State Park, of Río Flor del Bosque. We also give thanks to the technical representative Ing. Rafael Vazquez Zapata and to M. in C. Luis Enrique Martinez Romero who was the Research Coordinator in UMA.

REFERENCES

Agustin, M.L., 1992. La Perdiz Roja. Gestion del Habitat. Fundacion "La caixa". Jornadas Tecnicas. Espana. Ed. AEDOS.

Cabezas-Diaz, S., E. Virgos and R. Villafuerte, 2005. British Ornithologists´Union, España. Ibis, 147: 316-323.

Cepero, B.R., 2009. Avicultura Alternativa Retorno al pasado, o un camino al futuro?. Selecciones Avícolas. Facultad de Veterinaria de Zaragoza, pp: 73-79.

Cetin, O., 2002. Egg production and some hatchability characteristics of Rock Partridges (*Alectoris graeca*) mated at different rates. Turk. J. Vet. Anim. Sci., 26: 1009-1011.

Del Hoyo, J., A. Elliot and J. Sargatal, 1994. Handbook of the birds of the world. Vol. 2. New World vultures to guineafowl. Lynx Ediciones. Barcelona, Espana.

Ehrlich, P.R., D.S. Dobkin and D. Wheye, 1988. The birder's handbook. Simon and Schuster Inc. Nueva York, EUA.

Foster, W.H., 1968. The effect of light-dark cycles of abnormal lengths upon eggs production. Br. Poult. Sci., 9: 273-284.

Gaglianone, M.M.E., J. Ariki, P. Alves de Souza, H.B. Alves de Souza, V.M. Barbos de Moraes and F.C. Vargas, 2006. Carcass income and chemical composition of the native partridge (Rhynchotus rufescens-Tinamiformes) meat. Ciencia Rural, Santa Maria, 36: 258-262.

Gomez de Silva, H. and R.A. Oliveras de Ita Medellin, 2005. *Alectoris chukar*. Vertebrados superiores exoticos en Mexico: diversidad, distribucion efectos potenciales. Instituto de Ecologia, Universidad Nacional Autonoma de Mexico. Bases de datos SNIB-CONABIO. Proyecto U020. Mexico. D.F.

Gonzalez, R.P., 1997. Mejora de la calidad de la perdiz roja de granja. Mundo Ganadero, No. 94, Noviembre. Departamento de Producción Animal. ETSIA. Cordoba.

Gorrachategui, G.M., 1996. Alimentacion de aves alternativas: codornices, faisanes perdices. Iberica de nutricion animal. XII Curso de especializacion FEDNA, Madrid, 7 8 de Noviembre.

Hevia, M.L. and A. Quiles, 2005. Influencia de la Luz sobre el comportamiento de las aves. Depto. de Produccion Animal, Fac. de Veterinaria, Univ. de Murcia.

Kirby, J.D. and D.P. Froman, 2000. Reproduction in the Male birds. Sturkie's Avian Physilogy, Fifth edition, chapter, 23: 597 (Academics Press).

Krawczyk Jozefa, 2009. Quality of eggs from Polish native Greenleg Partridge chiken-hens manteined in organic vs. backyard production systems. Animal Science Papers and Reports, 27: 277-235.

Leonard, W., R. Aldo and M. Wilson, 2003. Programas de Iluminacion Rendimiento COBB 500.

Lera, R., 2005. Programas de iluminacion para la optimizacion economica de la puesta. Jornadas Profesionales de Avicultura de Puesta. Real Escuela de Avicultura. Valladolid, 27-29 Abril.

Lowe, R.W. and B.W. Heywang, 1964. Effect of various light treatments on egg production of October hatched White Leghorn pullets. Poult. Sci., 43: 11-15.

Lucas, L.M., L.E. Campbell and H.L. Marks, 1967. Lighting poultry houses. *Farmers Bulletin*, No. 2229, US. Dept. Agric. Washington, DC.

Mehmet, H.A. and O. Ozbey, 2008. The Effect of Different Housing on Egg Productivity and Hatchability in Rock Partridges. Eylul 22: 267-271. Erzincan, Turkiye.

Martinez, E., 2008. Memorias del IX Congreso XV Simposio Nacional de Ornitologia. Manejo conservacion de aves en el Parque Estatal Lazaro Cardenas del Río Flor del Bosque Puebla. Buap, pp: 18-24.

Martinez, F.A., T. Rigonatto, S. Ledesma, L.A. Antonchuk and N.H. Frescina, 2005. Catedra de Zoologia Recursos Faunisticos. Facultad de Cs. Veterinarias, UNNE, Argentina.

Morris, T.R., 1967a. The effect of light intensity on growing and laying pullets. World Poult. Sci., J., 23: 246-252.

Morris, T.R., 1967b. Light program for growing and laying pullets. World Poult. Sci. J., 24: 326-335.

Morris, T.R., 1964. Iluminacion para ponedoras: lo que sabemos y lo que necesitamos saber. World's Poult. Sci. J., 50: 283-287.

Nath, R.K. and W.N. Mark, 1976. Fractionated Egg Yolk Product. Appl., 347: 626. Cornell Research Foundation, Inc., Ithaca, N.Y. and West Chester, Pa. United States Patent.

Office National De La Chasse, 1994. Perdiz: la cria explotacion. Ed. Mandi-Prensa, pp: 134.

Ostrander, C.E. and C.N. Turner, 1961. Effect of various intensities of light on egg production of Single Comb White Leghorn pullets. Poult. Sci., 40: 1440. (Abstr.).

Perez Perez, F., 1981. La Perdiz Roja Espanola. Ed. Cientifico-medico. Barcelona, Espana, pp: 134.

Quintana, L.J.A., 2011. Avitecnia: Manejo de las aves domesticas mas comunes. 4ª edicion. Ed. Trillas. Mexico.

Ryan, F.A., E.P. Singsen, J.R. Carson, L.M. Potter and W.A. Junnile, 1959. Fourteen hour day versus all-night lights in poultry laying houses. Poult. Sci., 38: 1243. (Abstr.).

Robinson, F.E. and R.A. Renema, 1999. Principios de Manejo de los Fotoperiodos en Reproductoras de Engorda. Boll. Tecnico Vol. 7, No. 1.

Rosales, A.A., H.V. Bielller and A.B. Stephenson, 1968. Effect of lighting cycles on oviposition and egg production. Poult. Sci., 47: 586-591.

Ruiz, G.A., 1992. Produccion Avicola. Primera edicion. Fondo Editorial. Monografías Universitarias. Manizales, Colombia.

Siopes, T.D. and W.O. Wilson, 1981. Termination of photorefractoriness in chukar partridge (*Alectoris graeca chukar*) by low intensity. J. Reproductive Fertility, 63: 125-128.

Slaugh, B.T., N.P. Johnston, J.T. Flinders and J.A. Roberson, 1992. Synchronizing mating of male and female chukars. Anim. Technol., 43: 1.

USGS Herons, crames, coot and shorebirds AUO numbers 182-287 Longevity Record cited by Wilson, R. G. Y Ceballos, L.H., 1993, the birds of Mexico city 2° Edición

Woodard, A.E., R.L. Snyder and C.L. Fuqua, 1978. Testicular Regression and Recovery in the Chukar Partridge as affected by Photoperiod. Department of Avian Science, University of California, Davis, California. Poult. Sci., 57: 298-300.

Woodard, A.E., J.C. Hermes and C.L. Fuqua, 1986. Effects of Light Conditioning on Reproduction in Partridge. Department of Avian Science, University of California, Davis, California. Poult. Sci., 65: 2015-2022

Yannakopoulus, A.L., 1992. Greek experiences with game birds. Anim. Breeding Abstract, 61: 3375.