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EFFECT OF PHOTO-STIMULATION ON SOME EGG PRODUCTION TRAITS IN BROILER PARENTS

A. A. Enab, F.H. Abdou, G. A. Zanaty and H.A.A. Elsayed
Faculty of Agric., Minufiya Univ., Egypt.

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ABSTRACT: *A total of (5612 bird {4880 female + 732 male}) 1-d-old Cobb 500 broiler breeder pullets were randomly assigned to rearing house. All chicks were brooded and reared in rearing house under similar environmental, managerial and hygienic conditions throughout the trial period. A "Step down–step up" lighting program was used during brooding, rearing and production periods. were given continuous light during the first 2 d post hatch, were reared on 8-h photoperiods between 2 d and 20 wk of age, and were then transferred abruptly to 10-, 11-, 12-, 14-, or 15-h photoperiods at 20 wk. Controls remained on 8 h at 20 wk. The photoperiod was changed from 8 h Light/d to 15 h light/d. in order to estimate Body weight (BW), Growth Rate (GR), Feed Consumption (FC), Egg weight (EW), Egg production (H.H&H.D), Fertility (F), Hatchability (H), Number of chicken (CN), Age at sexual maturity (ASM).*

The main results obtained can be summarized as follows:

1. There were significant differences (P≤0.05) between males and females for body weight , feed consumption and mortality.
2. There are positive correlations between hen day production and egg weight, hatchability, fertility and number of chickens which ranged from (0.197 to 0.991).
3. The control group (C) reached sexual maturity earlier (164d), than the other groups which reached at (170 d and 174d) G2,G1 respectively.
4. There were significant differences (P≤0.05) between groups for feed consumption.
5. There were significant differences (P≤0.05) between phases for body weight, growth rate and feed consumption.
6. Fertility percentages during the study were 89.34, 85.01 and 89.59% for G1, G2 and control (C), respectively.
7. Hatchability percentages during the study were 77.96, 74.23 and 85.10 % for G1, G2 and control (C), respectively.
8. Number of chicken per hen during the study was 157.30, 144.55 and 141.50g for G1, G2 and control (C), respectively.
9. Means of BW between groups of birds were 4060.79, 4227.85 and 4176.25g in (C), (G1) and (G2) at 62 weeks in production period.

Key words: *Cobb 500,Body weight, Feed Consumption, Egg production, photo-stimulation*

INTRODUCTION

In the non-domesticated bird, the onset of sexual maturity is regulated by day length (Etches, 1993). It is believed that increasing day length provides a good stimulus for increased gonadotrophin secretion.

It is well documented that the pullet's response to light becomes important only as these birds approach sexual maturity. The growing period is usually regarded as being between 6 and 20 weeks of age, whilst pullets are exposed to a lighting program according to type of the rearing house. The research's suggested that delayed lighting increased post-peak, and total settable egg production, and also improved feed efficiency of low weight pullet to a level comparable to that of standard weight pullet lit at recommended age (Lien and Yuan 1994). The effect of size (8 h during rearing to 8, 10, 13, 16 h) and timing (at 42, 63, 84, 105, 126 or 142 day) of photoperiod increase on age at first egg, egg weight, egg production, egg output, and body weight (Lewis et al. 1997). Most broiler breeder research focused on feed allocation (restriction versus ad lib) and hatchability. A limited amount of research has been conducted in the area of broiler breeders lighting management. In practical terms, most basic protocols of lighting management have been developed primary breeding companies and integrated broiler companies.

Broiler breeders feed-restricted according to management guidelines show strong motivation to eat, both before and after consumption of the daily ration. It is crucial for males to reach a minimum body weight typical for a given breed, strain or type of performance. Photoperiod (daylight length) has the greatest effect on sexual maturity in domestic birds (Sauveur, and Reviers, 1988). Numerous studies have confirmed a substantial effect of the lighting program during rearing on the trait in question. Feeding strategy in broiler chickens, turkeys and rabbits should be result in high growth performance and improve feed conversion ratio. Early-life fast growth rate is accompanied by a number of problems, namely increased body fat deposition, high mortality, and high incidence of skeletal diseases. To tackle with these problems early nutrient restriction programmers were used. As a general conclusion it is evident in the Cobb product lines that first light stimulation is not age but body weight dependent. Uniformity of body weight determines in large part the sexual uniformity of the flock and hence the peak production performance and its persistency over %80 and 70% production (Cobb-Vantress, 2008).

MATERIALS AND METHODS

The present study was carried out at the Poultry Farm of The Egyptian Arab Company for Poultry - In- Kilo 72 Cairo-Alexandria Desert Road 6th of October City - Egypt. The Experiment lasted from November 2008 until February 2010.

Chicken stock and management:

A total of (5612 bird {4880 female + 732 male}) 1-d-old Cobb 500 broiler breeder pullets were randomly assigned to rearing house. All chicks were brooded and reared in rearing house under similar environmental, managerial and hygienic conditions throughout the trial period. A "Step down–step up" lighting program was used during brooding, rearing and production periods. were given continuous light during the first 2 d post hatch, were reared on 8-h photoperiods between 2 d and 20 wk of age, and were then transferred abruptly to 10-, 11-, 12-, 14-, or 15-h photoperiods at 20 wk. Controls remained on 8 h at 20 wk.

Studied traits:

The following traits were studied during the experimental period:

1. The average of live Body weight BW (gm), The Growth Rate GR (%) and The Feed Consumption FC (g/ bird).
2. Egg weight EW (gm) and Egg production H.H (egg) &H.D (%)
3. Fertility percentage F (%), Hatchability H (%) and Number of chicken CN (chicks).
4. Age at sexual maturity ASM (day).

Statistical Analysis:

Least-square means and their standard errors (LSM±S.E) for each studied trait were calculated in each group (G1, G2 and C). Also, phase and sex effects were studied, (Data analyzed produced from individuals had complete records), using (SPSS, 2004 for windows). Duncan's multiple range was used for the multiple comparisons of means (Duncan, 1955).

These traits were analyzed using the following fixed model:

Yijkl = μ + Gi + Pj + Xk + (GP)ij +(PX)ik + (GX)jk + (GPX)ijk + eijkl Where:

Yijkl = the observation on the ijklth bird.

μ = the overall mean of the trait.

Gi = the effect of ith Group.

pj = the effect of jth Phase.

Xk = the effect of kth sexual ratio.

(GP) ij = the interaction effect between ith Group and jth Phase.

(GX) ik = the interaction effect between ith Group and kth sexual ratio.

(PX) jk = the interaction effect between jth Phase and kth sexual ratio.

(GPX) ijk= the interaction effect between ith Group and jth Phase and kth sexual ratio.

eijkl = the random error component assumed to be normally distributed.

RESULTS AND DISCUSSION

1. Phenotypic correlation estimates among some traits:

Phenotypic correlation estimates among some traits in Cobb broiler parents chicken are given in Table (1). The results explained that the phenotypic correlation estimates between (WM) with CM, BW and CFC were positive and high, being 0.716, 0.620 and 0.187, respectively. However, data in (Table 1) indicated also that the phenotypic correlation estimates between (WM) with GR and WFC were negative and high, being –0.16 and -0.573, respectively.

2. Phenotypic parameters of some egg production traits in Cobb 500 broiler breeder chicken:

2.1. Body Weight (BW):

The results presented in Table (2) showed that, body weight means in all groups have highly significant differences (P<0.01) between groups. In age phases there high significant differences (P<0.01) in it, the first one of this phase is the phase (3). There are no-significant differences in body weight of male and female in all groups, Female in (G1) have highly body weight than (G2, C) groups, this results compatible with Zatter (1994) he found that there is a significant differences (P<0.05) in body weight of male and female in the same condition, also Abou El-Ella *et al.,* (2002) and Hassan (2006) reported the same results. The differences in body weight among treatments became insignificant. Many investigators stated that, body weights of males were significantly heavier than those of females Salem (1993).

2.2. Growth Rate (GR):

The results in (Table 3) showed that in all groups have no-significant differences (P<0.05) between groups for (GR) traits. There is no- significant (p < 0.05) in (GR) traits between phases and sexes. The means of growth rate during the production period were 1.69, 0.93 and 0.85 in groups (C), (G1) and (G2), respectively. Also the highest (GR) were in phase (1), than phase (2) and (3). There are no significant differences in (GR) traits of male and female. These results are in agreement with those reported by the cumulative growth could be represented by the curve of weight against time and is often described by mathematical growth functions (Parks, 1971).

Table (1): Correlation estimates among some traits in Cobb broiler parents chicken.

TRAITS	CM	BW	GR	WFC	CFC
WM	.716**	.620**	-.016	-.573**	.187**
CM		.840**	-.096	-.510**	.568**
BW			.312**	-.614**	.358**
GR				-.052	-.155*
WFC					.253**

*. Correlation is significant at the 0.05 level.

**. Correlation is significant at the 0.01 level.

Table 2

Table 3

2.3. Feed Consumption (FC):

Ration represents the major cost item in poultry production and often accounts for about 60-65 % of total production costs. In Table (2) the weekly feed consumption in group (C) was higher than the other groups which have the means 145.12, 139.76 and 139.38 for (C), (G2) and (G1), respectively, during the production period. The present results are in agreement with those reported by Bentsen (1983a) showed that significant differences were found in percentage of feed consumption between lines during the first part of the laying. Sources of variation in feed consumption were shown by Bentsen (1983b) he stated that negative genetic correlation between feed consumption and age at sexual maturity was noticed. Fairfull and Chambers (1984) found that there was appositive genetic correlation between feed consumption and age at sexual maturity.

2.4. Egg Weight (EW):

Correlated response for egg weight was obvious and this may be due to the correlations between it with feed consumption. Egg size in chickens is the most economically important item not only for hatching operation or human consumption but also for other industry needs. However, improving egg size to the standard weight (i.e. 55-60 g) is essential in breeding programs to achieve good performance results in raising chickens. In Table (4) the egg weight in group (G1) was higher than the other groups which have the means 66.48, 65 and 63.83g for (G1), (G2) and (C), respectively, during the production period. Also in this table there are differences in (EW) and the phase (3) was higher than phase (1) and (2). The present results are in agreement with those reported by Leeson and summers (1980) reported that early light stimulation decreased egg weight due to its positive correlation with sexual maturing. Egg weight is largely affected by the environmental factors and food restriction (Shaler and Pasternak, 1993), along with evidence of genetic involvement including breed effect. Many studies have shown that early egg weight was increased by increasing dietary energy (Bohnsack *et al.,* 2002; Sohail *et al.,* 2003 and Wu *et al.,* 2005). Mean egg weight was negatively related to photoperiod, decreasing by 0.3 g per 1-h, but positively linked to AFE, increasing by 0.1 g for each 1-d delay in AFE (Lewis and Gous, 2006), also they reported that faster growth did not significantly increase egg numbers or mean egg weight.

2.5. Egg Production (H.H&H.D):

The most important factor in egg production is rate of laying. Table (4) shows the variability in hen-day egg production rates for the various experimental treatments all over the experimental period. Also in this table (HH) production means in (G1) is higher than (G2) and (C) and have 95.49, 92.01and 88.18, respectively. Also in phases the greatest values were in phase (3) than phase (1) and (2). The (HH) were 179.20, 172.00 and 168.34 Egg for groups (G1), (C) and (G2).

The present results are in agreement with those reported by Harms and Russell (1996) and Akbas and Takma (2005) they found that body weight was positively related to egg production. Broiler breeder hens come into lay in response to increases in the day length when made at the appropriate time. Egg numbers to 39 wk increased by 0.75 for each 1-d earlier AFE Lewis and Gous, (2006). The response of the hens to light stimulation is based on their condition, body weight and age (Cobb-Vantress, 2008). El-Sheikh et *al* (2009) reported that essential phospholipids supplementation had no significant effects on egg production.

2.6. Fertility (F):

Fertility is one of the most important reproductive traits in chickens, it is affected by different factors such as: mating ratio, parental age, rate of Laying, climatic and managerial conditions. The data in Table (5) show that the overall means of fertility percentages of the three groups were 89.34, 85.01 and 89.59% in the groups (G1), (G2) and (C), respectively. These results observed that the highest value of these traits was in group (C) than (G1) and (G2).

Table 4

The present results are in agreement with those reported by Deeming and Van Middelkoop (1999), and El-Safty (2012b) reported that as the flock ages, there was more infertility and early embryonic mortality in eggs from Ross 308 compared with Cobb 500. Jones *et al.* (1976) found that hens fed the high-energy diet had significantly higher egg fertility than those fed the lower energy levels. El-Fiky (2002) showed that fertility rates were significantly affected (P<0.01) by parental age. The fertility of chicken eggs may be highly varied due to poor management and improper proportion of males or poor ability of males to produce viable sperms El-Safty (2012a). Fertility also depends on her mate's ability to mate successfully, quantity and quality of semen deposited (Wilson *et al.,* 1979; Brillard, 2003).

2.7. Hatchability (H):

Hatchability of fertile eggs in birds is affected by different factors such as: parental age, rate of laying and pre – incubation storage. The data in Table (5) show that the overall means of hatchability percentages of the three groups were 77.96, 74.23 and 85.10% in the groups (G1), (G2) and (C), respectively.

The present results are in agreement with those reported by (Smith, 2000), he also reported that the hatching yield from medium sized poultry eggs was superior to the hatching yields of large and small eggs; the hatching yield of very large eggs and the small eggs were poor. Farooq *et al.* (2001) reported that significant effect of egg weight on hatchability of hens. Egg weight had an insignificant impact on fertility and hatchery productivity (Narushin and Romanov 2002). Islam *et al.* (2002) reported that breed had little effect on hatchability of fertile eggs.

2. 8. Number of chicken (CN):

The productivity of a breeding operation can be measured by the number of quality eggs produced and the number of quality chicks obtained from these eggs. The data in Table (5) show that the overall means of Number of chicken of the three groups were 157.30, 144.55 and 141.50 in the groups (G1), (G2) and (C), respectively. The present results are in agreement with those reported by Farooq *et al.* (2001) reported that significant effect of egg weight on weight of newly hatched chick. Study of body weight traits in a breeding program is also influenced by body weight of the newborn chick (Khurshid *et al.,* 2003). The chicks were carefully removed from the pouches and their weight were determined by using an electronic scale with a sensitivity of 0.01 g. chick quality criteria laid out (Tona *et al.* 2003). The relevant quality criteria consisted of the chick's activity level, dryness and cleanliness, absorption of the yolk sac, eyes (lively looks), legs (good posture, no redness and deformity), appearance of umbilical region (normal coloring, complete absorption of yolk sac), whether or not the chick carries any remaining membrane or yolk sac remnants. Eggs, which did not hatch were individually examined and separated and recorded according to late mortality or dead in shell.

2.9. Age at Sexual Maturity (ASM):

Sexual maturity is considered an indicator for egg number as a result of negative correlation between them, where early matured chickens may have chance to produce more eggs. Fig (1) showed that The control group (C) reached sexual maturity earlier (164d), than the other groups which reached at (170 d and 174d) G2,G1 respectively. The present results are in agreement with) Abdou and Enab, 1994, El-Hadad, 2003 and Ben Naser, 2007).The conclusion of previous literatures showed that the mean of age at sexual maturity for Norfa strain of chicken ranged from 134.1 to197.0 days (Abou Sada, 2007). Younis and Abd El-Ghany (2004) noticed that averages of age at first egg for Sliver Montazah chickens were 180.7, 174.8 and 168.1 d in generation one, two and three, respectively. Ensaf *et al.* (2000), they reported that averages of age at first egg were 181.7, 187.4 and 183.7 d, respectively.

Table 5

Fig 1

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تأثير الإثارة الضوئية علي بعض صفات إنتاج البيض في أمهات دجاج اللحم

أحمد عبد الوهاب عنب ، فاروق حسن عبده ، جمال عبد الستار زناتي ،

حسام عبد الرازق عبد الرؤف السيد

قسم إنتاج الدواجن ، كلية الزراعة بشبين الكوم ، جامعة المنوفية

الملخص العربي:

أجريت هذه الدراسة في مزارع دواجن الشركة العربية المصرية للدواجن –كيلو ٧٢طريق القاهرة الإسكندرية الصحراوي مدينة ٦ أكتوبر – جمهورية مصر العربية.واستمرت التجربة من نوفمبر ٢٠٠٨ وحتى فبراير ٢٠١٠. لإجراء بعض الدراسات على صفات إنتاج البيض {مثل إنتاج البيض (H.H وH.D) ، الخصوبة (F) ، الفقس (H) ، عدد الكتاكيت الناتجة ، وزن البيضة (EW) ، العمر عند النضج الجنسي ووزن الجسم (BW)} بالإضافة إلى بعض الصفات الأخرى، ومحاولة تحسينها من الناحية الاقتصادية ، وذلك علي سلالة Cobb 500 لأمهات دجاج اللحم.

ويمكن تلخيص النتائج المتحصل عليها كالآتي:

١. وجدت اختلافات معنوية ($P \leq 0.05$) بين الذكور والإناث لصفة وزن الجسم في مراحل العمر المختلفة، واستهلاك العلف ومعدل النفوق.

٢ . وجد ارتباط موجب بين (HD) وصفات وزن البيض، نسبة الفقس والخصوبة وعدد الكتاكيت المنتجة لكل أم والتي تراوحت من (٠.١٩٧ : ٠.٩٩١).

٣. كان العمر عند النضج الجنسي لمجموعة الكنترول ١٦٤يوم ، بينما كان في المجموعتين الثانية والأولي (١٧٠ يوم و١٧٤يوم)G2 , G1 على التوالي.

٤. وجدت اختلافات معنوية($P \leq 0.05$) بين المجموعات في استهلاك العلف.

٥. وجدت اختلافات معنوية($P \leq 0.05$) بين المراحل العمرية لصفات وزن الجسم، ومعدل النمو، واستهلاك العلف.

٦. كانت متوسطات نسب الخصوبة أثناء الدراسة ٨٩.٣٤, ٨٥.٠١ , ٨٩.٥٩٪ في المجموعات G1 ، G2 و (C) على التوالي.

٧. كانت متوسطات نسبة الفقس خلال الدراسة ٧٧.٩٦– ٧٤.٢٣– ٨٥.١٠٪ في المجموعاتG1، G2 و (C) على التوالي.

٨. كان عددالكتاكيت الناتجة من كل دجاجة مسكنة أثناء الدراسة ١٥٧.٣٠, ١٤٤.٥٥ و١٤١.٥٠ كتكوت في المجموعاتG1، G2 و (C) على التوالي.

٩. كانت متوسطات وزن الجسم BW لمجموعات الطيور ٤٠٦١, ٤٢٢٧ و٤١٧٦جم في، (G1) (C) و (G2) علي التوالي خلال فترة الإنتاج.

Table (2): Least squares means (LSM± S.E) of (BW, GR, WFC) traits of both males and females in Cobb 500 Broiler Parents chickens.

FACTORS \ TRAITS		BW		GR		WFC	
		N	Least squares means± S.E	N	Least squares means± S.E	N	Least squares means± S.E
GROUP	G1	84	$4227.85^{a}\pm49.62$	81	$0.93^{a}\pm0.15$	84	$139.38^{b}\pm2.77$
	G2	84	$4176.25^{a}\pm53.89$	81	$0.85^{a}\pm0.10$	84	$139.76^{b}\pm2.72$
	C	84	$4060.79^{b}\pm65.20$	81	$1.69^{a}\pm0.87$	84	$145.12^{a}\pm1.79$
PHASE	1	84	$3783.42^{c}\pm45.11$	77	$1.77^{a}\pm0.17$	84	$141.75^{a}\pm2.72$
	2	78	$4226.26^{b}\pm56.99$	76	$1.35^{a}\pm0.93$	78	$141.78^{a}\pm2.59$
	3	90	$4439.94^{a}\pm43.69$	90	$0.47^{a}\pm0.03$	90	$140.8^{a}\pm2.16$
SEX	MALE	126	$4514.79^{a}\pm39.11$	120	$1.51^{a}\pm0.59$	126	$120.33^{b}\pm0.64$
	FEMALE	126	$3795.13^{a}\pm27.09$	123	$0.81^{a}\pm0.09$	126	$162.51^{a}\pm0.82$

BW= body weight, WFC= weekly feed consumption,
GR= growth rate

Table (3): Analysis of variance of (BW, GR, WFC) traits in Cobb 500 Broiler Parents chickens.

Source of variation	BW		GR		WFC	
	d	Mean squares	d	Mean squares	d	Mean squares
G	2	600248.152**	2	21.903^{ns}	2	860.740**
P	2	9.651E+06**	2	38.592^{ns}	2	26.984^{ns}
S	1	3.245E+07**	1	34.919^{ns}	1	112234.860**
G * P	4	47983.648^{ns}	4	31.233^{ns}	4	79.174^{ns}
G * S	2	124251.153^{ns}	2	27.291^{ns}	2	2248.785**
P * S	2	134346.749^{ns}	2	23.441^{ns}	2	119.328^{ns}
G * P * S	4	75812.742^{ns}	4	25.281^{ns}	4	96.217^{ns}
Error	234	60336.22	234	20.884	234	41.624

* Significant ($p \leq 0.05$), ** highly significant ($p \leq 0.01$).

Table (4): Least squares means (LSM± S.E) of (HD, HH, EW, WF) traits of females in Cobb 500 Broiler Parents chickens.

FACTORS / TRAITS		HD		HH		EW		WF	
		N	Least squares means± S.E	N	Least squares means± S.E	N	Least squares means± S.E	N	Least squares means± S.E
GROUP	G1	42	82.61^{a}±7.76376	42	95.49^{a}±8.72508	42	66.48^{a}±0.99139	42	71.82^{a}±1.77088
	G2	42	77.67^{a}±7.16282	42	92.01^{ab}±8.21688	42	65^{b}±0.89974	42	69.72^{a}±1.74916
	C	42	73.49^{a}±7.13719	42	88.18^{b}±8.5167	42	63.83^{c}±0.82634	42	72.84^{a}±1.80375
PHASE	1	42	21.26^{a}±2.66993	42	26.72^{c}±3.20907	42	58.38^{c}±0.78232	42	67.79^{b}±2.97805
	2	39	80.32^{a}±2.5372	39	94.49^{b}±2.84534	39	66.59^{b}±0.24566	39	74.31^{a}±0.27107
	3	45	128.73^{b}±2.07613	45	150.47^{a}±2.3131	45	70.09^{a}±0.28749	45	72.41^{ab}±0.301
S	7	11	65.33^{c}±21.6237	11	76.58^{b}±2.505053	11	61.45^{b}±2.89942	11	64.01^{b}±6.44878
	8	56	91.72^{b}±4.58284	56	109.06^{a}±5.41242	56	66.48^{a}±0.3898	56	73.97^{a}±0.27509
	9	12	39.71^{a}±4.79845	12	49.31^{c}±5.52506	12	62.33^{b}±0.81958	12	72.92^{a}±0.28533
	10	47	74.19^{b}±7.80969	47	85.89^{b}±8.80372	47	65.02^{a}±1.09303	47	69.83^{ab}±2.20897

HD= hen day production, HH= hen hose,
EW= egg weight, WF= weekly fertility

Table (5): Least squares means (LSM± S.E) of (CF, WH, CH, WCN, CCN) traits of females in Cobb 500 Broiler Parents chickens.

FACTORS TRAITS		CF		WH		CH		WCN		CCN	
		N	Least squares means± S.E	N	Least squares means± S.E	N	Least squares means± S.E	N	Least squares means± S.E	N	Least squares means± S.E
GROUP	G1	42	71.70^{a}±1.76739	42	64.61^{a}±2.2983	42	64.66^{a}±2.29093	42	82.61a±7.76376	42	82.61^{a}±7.76376
	G2	42	69.52^{a}±1.74676	42	63.19^{a}±2.25961	42	63.17^{a}±2.24729	42	77.67a±7.16282	42	77.67^{ab}±7.16282
	C	42	72.75^{a}±1.80356	42	65.33^{a}±1.68267	42	65.94^{a}±1.64879	42	73.49a±7.13719	42	73.49^{b}±7.13719
PHASE	1	42	67.05^{b}±2.95403	42	59.24^{b}±3.43518	42	58.24^{b}±3.36997	42	21.26b±2.66993	42	21.26^{c}±2.66993
	2	39	74.35^{a}±0.25992	39	69.67^{a}±0.252	39	69.59^{a}±0.1663	39	80.32a±2.5372	39	80.32^{b}±2.5372
	3	45	72.70^{a}±0.25287	45	64.59^{a}±0.35376	45	66.18^{a}±0.31416	45	128.73c±2.07613	45	128.73^{a}±2.07613
S	7	11	63.83^{b}±6.40441	11	56.84^{b}±5.75549	11	56.82^{b}±5.7174	11	65.33c±21.6237	11	65.33^{c}±2.16237
	8	56	74.02^{a}±0.25209	56	67.22^{a}±0.39574	56	67.85^{a}±0.20148	56	91.72b±4.58284	56	91.72^{a}±4.58284
	9	12	72.55^{a}±0.32471	12	68.29^{a}±0.71169	12	67.74^{a}±0.70316	12	39.71a±4.79845	12	39.71^{d}±4.79845
	10	47	69.55^{ab}±2.20897	47	61.75^{ab}±2.81126	47	61.72^{ab}±2.80618	47	74.19b±7.80969	47	74.19^{b}±7.80969

CF= cumulative fertility, WH= weekly hatchability
CH= cumulative hatchability, WCN= weekly Number of chicken
CCN= cumulative Number of chicken

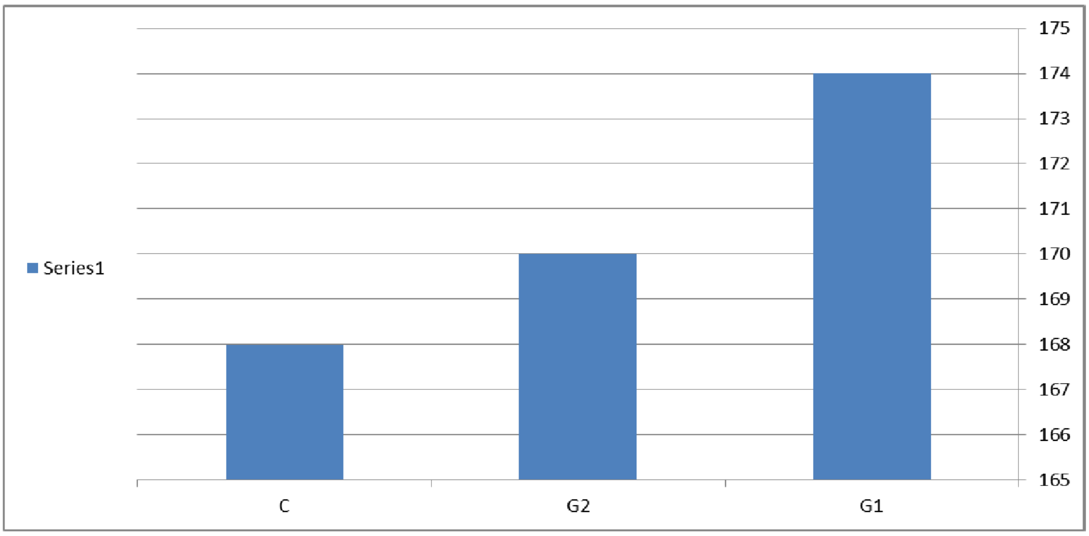

Fig (1): Age at sexual maturity (ASM)