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EFFECTS OF SUPPLEMENTATION OF DAYLIGHT WITH ARTIFICIAL LIGHT AT DIFFERENT INTENSITIES AND SEX RATIO ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF DOMYATI DUCKS.

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ABSTRACT

A 4 x 2 factorial experiment was carried out to evaluate the effects of four supplementary light intensity levels in combination with two sex ratios on the productive and reproductive performance of Domyati ducks. Eighteen-week-old, 552 Domyati ducks (456 duck hens and 96 drakes) were randomly distributed into 8 groups; four of which had a sex ratio of 6:1 while the other four groups had a sex ratio of 4:1 (duck hens:drake) of three replicates each, housed separately in floor pens and exposed to a daily photoperiod of 17 hours up to the end of the experiment at 60 weeks of age. To maintain this daily 17-hour photoperiod throughout the experimental period from 20 to 60 weeks of age, the length of natural day light was supplemented with artificial light, providing light intensity levels of 1 5 (served as a control), 10, 45 or 90 lux at birds' head level of the four experimental groups within each sex ratio respectively.

The criteria of response were laying performance (age at sexual maturity, total eggs number, laying rate%, egg weight, egg mass, feed consumption and feed conversion), eggs fertility and hatchability percentages, some egg quality traits (egg weight, shell weight, albumen weight, yolk weight, shell thickness and egg shape index), some morphological measurements on reproductive organs (testicular, ovarian and oviduct weights and oviduct length), and concentrations of some blood constituents (total protein, albumin and globulin), and gonadotrophic hormones (LH and FSH).

Significant differences were observed in total eggs number, laying rate %, egg mass, feed intake and feed conversion; but were not observed in age at sexual maturity or egg weight, due to the effects of supplementary light intensity level or sex ratio, in favor of the 10-lux supplementary light intensity and 6:1 sex ratio

Eggs fertility and hatchability were significantly improved by exposing ducks with 6:1 sex ratio to the 10-lux supplementary light intensity, and no further improvement was achieved upon subjecting the ducks to 45 or 90 lux.

With the exception of a higher oviduct weight achieved with the 6:1 sex ratio, neither supplementary light intensity level nor sex ratio affected significantly the testicular and ovarian weight or the oviduct length.

Egg quality was not significantly influenced by either supplementary light intensity level or sex ratio, except that a higher eggshell weight was achieved by the exposure of ducks to supplementary light intensity levels of 10, 45 or 90 lux.

Significant differences were detected only in levels of blood plasma total protein and globulin; in males at 40 weeks of age and in females at 60 weeks of age, due to the effect of supplementary light intensity level.

Significant supplementary light intensity level by sex ratio interactions were found only for total eggs number, laying rate %, egg mass and feed conversion, whereas their effects were not interrelated for the other criteria.

It could be concluded that, the use of a 10-lux artificial light in supplementing the natural daylight length; to achieve a daily 17-hour photoperiod, in combination with a sex ratio of 6:1 (duck hens:drake) for breeder Domyati ducks, is economic and adequate to attain a satisfactory productive and reproductive performance.

Keywords: Domyati ducks, supplementary light intensity, sex ratio, laying performance, fertility and hatchability, egg quality, blood constituents.

INTRODUCTION

Water fowls (ducks and geese) production is one of poultry production branches which contributes in supplying meat, eggs and fatty liver. In addition, they have natural immunity against some chicken infectious diseases, such as Newcastle, Marek's disease and Leukosis.

The environmental conditions such as photoperiod, light color and intensity, nutritional status, housing density and sex ratio are contributing factors affecting the reproductive performance of ducks.

The principles of photoperiodism are not complicated, but their application in practical poultry production has sometimes been misunderstood. It seems worthwhile, therefore, to go over some old ground, pointing out as we go some of the lessons that seem not to have been fully applied in practice (Morris, 2004).

Early studies were concerned to explain the influence of natural day-length on the performance of laying fowls (Whetham, 1933; Morris and Fox, 1958).

Although the effects of artificial day lengths on the reproductive performance of domestic poultry is well described, yet the responsiveness to light intensity is not well defined. In general, long day-lengths such as 14 to 16h light/day with a minimum light intensity threshold level are used to stimulate and maintain reproduction, and artificial light is often necessary to supplement the length of natural daylight in curtain sided poultry breeder houses (Davis *et al.*, 1993).

Early studies (Morris and Owen, 1966) indicated that a minimum light intensity of about 10 lux was needed to support normal egg production, but no additional benefit was observed for increasing the light intensity beyond that level. Lewis and Morris (1999) showed that rate of lay exhibits a curvilinear response to illuminance and that a light intensity of 5 lux probably gives the optimal balance between lighting cost and egg production income. A more recent study with growing pullets indicates a photoperiodic threshold at around 2 lux (Lewis *et al.*, 1999). Hill *et al.* (1988) and Tucker and Charles (1993) have shown no significant differences in egg yield with light intensity levels ranging from 34 to 1.75 lux.

However, one scientific report indicated a negative effect of increasing light intensity on egg production in turkeys (Jones *et al.*, 1982), as they reported that hens exposed to 160 lux had poorer egg production than hens subjected to 85 lux.

One of the major problems encountered by the duck producers is determining the optimumal sex ratio (number of female ducks/drake to achieve the optimum reproductive efficiency in breeder flocks. The commonly used ratio of females to male in duck breeder stock is 4 duck hens:1 drake

(20% males). Davis *et al.* (1993) indicated that a breeder duck flock having 15% males was capable of achieving optimum eggs fertility.

The present study was designed to evaluate the effects of using different levels of supplementary light intensity levels and sex ratios on some productive and reproductive traits of Domyati ducks.

MATERIALS AND METHODS

The present study was carried out at El-Serw Poultry Research Station, El-Serw, Domietta, belonging to the Animal Production Research Institute, Agricultural Research Center, Egypt.

Experimental birds and management:

Domyati ducklings were obtained from EL-Serw hatchery unit and housed in well-ventilated, wheat straw-littered brooding pens for the first 4 weeks of age. Brooding temperature was maintained at about 30^0 C at the first three days of age; using gas heaters, then it was decreased daily by 0.5^0 C until reached 25^0 C and kept constant up to 21 days of age. Thereafter, the ducklings were permitted to move freely to yards during the day light period.

Ducklings were fed a starter ration from one-day old to 6 weeks of age and a grower ration from 6-18 weeks of age, thereafter, a layer ration was offered from 18 weeks of age up to the end of the study (60 weeks of age). Composition and chemical analysis of all rations are shown in Table 1. Rations were offered to birds in a dry-mash form. Fresh and clean water was available all the time.

Table (1): Composition and chemical analysis of the rations offered to the ducks throughout the experimental period.

Ingredients (%)	Starter	Grower	Layer
Yellow corn	65.00	63.00	66 00
Soybean meal (44%)	30.45	15.50	21.50
Wheat bran	0.65	17.78	2 74
Dicalcium phosphate	1.80	1.25	1.50
Limestone	1.40	1.80	7.60
Vit. + Min. premix **	0.30	0.30	0.30
Salt (NaCl)	0.30	0.30	0.30
D.L. Methionine	0.10	0.07	0.06
Total	100	100	100
Calculated analysis *** :			
Crude protein; (%)	19.12	15.04	15.5
ME (Kcal/kg)	2865	2687	2724
Total calcium ;(%)	1.03	1.04	3 41
Total phosphorus; (%)	0.72	0.72	0.64
Methionine; (%)	0.15	0.11	0.1
Lysine; (%)	0.11	0.09	0.09

* All ingredients were available at El-Serw Station; where they were ground and then well mixed.

** Contents per 3 kg premix: Vitamin A 10,000,000 IU, vitamin D_3 1,000,000 IU, vitamin E 10 g, vitamin K_3 1 g, vitamin B_1 1 g, vitamin B_2 4 g, nicotinic acid 20 g, pantothenic acid 10 g, vitamin B_6 1.5 g, vitamin B_{12} 10 mg, folic acid 1 g, biotin 50 mg, choline 500g, zinc 45g, copper 3 g, iodine 0.3 g, iron 30 g, selenium 0.1 g, manganese 40 g and carrier $CaCO_3$ to 3000 g.

*** According to NRC (1994)

Experimental design and Light regime practiced:

Using artificial light source to supplement the length of natural daylight, during the first week of age ducklings were kept under a 24-hour photoperiod per day, afterwards the length of daily photoperiod was decreased by 2 hours weekly until reached 14 hours daily at the 6^{th} week and maintained constant up to 18 weeks of age, then it was gradually increased by one hour weekly until the daily photoperiod reached 17 hours at the 21^{st} week and kept constant up to the end of the study at 60 weeks of age.

At 18 weeks of age, 552 healthy birds (456 females and 96 drakes) were chosen randomly, weighed and leg banded; then they were distributed into 8 experimental groups; four of which consisted of 60 duck hens and 15 drakes each (with sex ratio of 4 females to 1 drake), whereas the other four groups consisted of 54 duck hens and 9 drakes each (with sex ratio of 6 females:1drake) of 3 equal replications, housed separately in a well-ventilated, wheat straw-littered floor pens. At 20 weeks of age groups of ducks within each sex ratio were exposed to different supplementary light intensity levels of 1.5 (served as a control), 10, 45 or 90 lux, respectively, to the end of the study at 60 weeks of age.

Thus, during the experimental period from 20 to 60 weeks of age the natural day light was supplemented by artificial light to reach a daily photoperiod of 17 hours. This supplementary artificial light was supplied by incandescent bulbs (fitted with reflectors) having electric powers of 10, 40, 100 or 200 watts, installed at a height of 2.1 m from the litter, providing light intensity levels of 1.5 (control), 10, 45 and 90 lux at the levels of birds' head, respectively. Light intensity was measured by a photometer as an average of five readings at 5 sites in each pen. The supplementary artificial light period was divided to be one hour in early morning before sun-rise and the remainder was added at sunset (North and Bell, 1990) using automatic switch timer.

Parameters estimated:

Laying performance (20-60 weeks):

Age at sexual maturity was estimated as the age of ducks at which the first egg was produced in each pen. Also, records on total eggs produced per duck, laying rate%, egg weight, egg mass, feed intake and feed conversion (g feed/g egg) were maintained.

During the duration of this study, 8 batches of hatching eggs were incubated monthly, beginning at the 2^{nd} month of lay. Eggs fertility was examined at the 7^{th} day of incubation. Hatchability percentage (% of fertile eggs) was also calculated. Four egg quality tests (120 eggs in each test) were performed when the ducks were 24, 32, 40 and 60 weeks of age, to evaluate some parameters of egg quality (egg weight, shell weight, albumen weight, yolk weight, shell thickness and egg shape index). At the end of the experiment (60 weeks of age), 6 birds per treatment (3 males and 3 females) were slaughtered to take some measurements on the reproductive organs (weights of testes, ovary and oviduct, as well as oviduct length).

Blood constituents:

Blood samples were collected at 40 and 60 weeks of age from the wing veins of 6 drakes and 6 female ducks per treatment into heparinized tubes, then blood plasma was seprated by centrifugation at 3000 rpm for 15 minutes. Some blood plasma constituents were estimated, in the laboratories of Animal Production Research Institute, Dokki, Cairo; using commercial kits (Pasteur Lab. Egypt-USA) for the determination of concentrations of plasma total protein (Doumas, 1975), albumin (Doumas *et al.,* 1971), and LH and FSH (Moudgal and Madhwa Raj, 1974).

Economic efficiency:

Production costs were estimated on the basis of the prevailing market prices of electricity, feeds and day-old ducklings during the experimental period. Economic efficiency (EE) was calculated as net returns times 100 divided by total cost.

Statistical analysis:

Obtained data were analyzed by a two-way analysis of variance, using the General Linear Models procedures of the statistical analysis system (SAS, 1996). Duncan's multiple range test (Duncan, 1955) was used to detect the significant differences between means of the different groups.

RESULTS

Laying performance:

Due to the application of supplementary lighting intensities, significant differences ($P \leq 0.01$) were observed in total number of eggs produced per duck, laying rate %, total egg mass/duck, feed consumption/duck and feed conversion ratio, while age at sexual maturity and egg weight were not significantly affected (Table 2). The age at sexual maturity was approximately equal for duck groups subjected to 10, 45 or 90 lux. It was observed that the 1.5 lux-group (control) was the latest one to reach sexual maturity. It was observed that subjecting the ducks to supplementary light intensities from 10-90 lux resulted in significantly higher means of egg production (laying rate%) than the control group (1.5 lux). The best egg production was recorded for ducks kept under supplementary light intensity level of 10 lux, whereas the poorest one was recorded for the control ducks. Meanwhile, the ducks subjected to 45 and 90 lux were intermediate in this respect. Total egg mass per duck ranged from 11.13 kg (10 lux-group) to 7.79 kg (1.5 lux-group). The best value of feed conversion ratio (4.07) was exhibited by the 10 lux-group, while the poorest one (5.43) was recorded for the 1.5 lux-group (control). The 10 lux-group was the best in respect of egg weight followed by 45, 1.5 and 90 lux treatments in a descending order with no significant differences. Increasing the supplementary light intensity beyond 1.5 lux (control) increased the total feed consumption per duck throughout the whole experimental period (20-60 weeks of age) by 9.3, 8.5 and 8.3% for ducks exposed to 10, 45 and 90 lux, respectively (Table 2).

With regard to the effect of sex ratio, the present results indicated that groups of ducks having the wide sex ratio (6:1) attained significantly ($P \leq 0.01$) greater values for egg production (laying rate%), egg mass and feed consumption and better feed convertion than those of the narrow sex ratio (4:1). No significant differences were detected, however, in age at sexual maturity or egg weight (Table 2), due to the effect of sex ratio.

Table (2): Effects of supplementary light intensity level and sex ratio on laying performance of Domyati ducks from 20 to 60 weeks of age

Treatments		Age at sexual maturity (days)	Total eggs produced/ duck	Laying rate (%)	Egg weight (g)	Total egg mass (kg) per duck	Feed consumption (kg) per duck	Feed conversion ratio (g feed/g egg)
Light intensity level (Lux);L	L_1 (1 5)	163 2± 1 38	119.0±8.5[c]	42.5±3.04[c]	65.1±0.2	7.795±0.54[d]	41.481±0.22[c]	5.43±0 4[a]
	L_2 (10)	158.2±0.79	173.0±2.9a	61.8±1.02[a]	65.4±0.3	11.135±0.21[a]	45.323±0 21[a]	4.07±0 1[d]
	L_3 (45)	58.5±0.96	165.0±2.6[b]	58.9±1.0[b]	65.3±0.4	10.329±0.35[c]	44.988±0.33[b]	4.40±0.1[b]
	L_4 (90)	158.7±4.62	163.8±1.7[b]	58.5±0.6[b]	64.6±0.3	10.637±0 10[b]	44.934±0.21[b]	4.23±0 03[c]
Sex ratio; S(females : drake)	S_1 (4 1)	159.9±1.33	147.4±8.3[b]	52.7±3.0[b]	64.8±0.2	9.321±0.49[b]	43.671±0.47[b]	4.83±0 3[a]
	S_2 (6 1)	159.3±2.14	163.0±4.8[a]	58.2±1.7[a]	65.3±0.2	10.627±0.30[a]	44.693±0.48[a]	4.22±0.1[b]
Interaction; LXS	L_1XS_1	163.3±2.03	100.3±1.5	35.8±0.5	65.6±0.4	6.595±0.08	41.009±0.05	6.23±0.1
	L_1XS_2	163.0±2.31	137.7±3.3	49.2±1.2	65.1±0.3	8.996±0.04	41.953±0.16	4.63±0.03
	L_2XS_1	158.3±0.88	167.0±1.0	59.7±0.4	64.7±0.6	10.684±0.02	44.895±0.14	4.20±0.0
	L_2XS_2	158.0±1.53	179.0±2.0	63.9±0.7	65.6±0.1	11.586±0.14	45.752±0.13	3.93±0 03
	L_3XS_1	159.0±2.00	160.7±3.4	57.4±1.2	64.7±0.5	9.555±0.02	44.292±0 21	4.63±0 03
	L_3XS_2	158.0±0.58	169.3±2.2	60.5±0 8	65 8±0.4	11 103±0.02	45.685±0.15	4.10±0.0
	L_4XS_1	159.0±4.73	161.7±1.7	57.7±0.6	64.4±0.2	10.449±0.01	44.488±0.12	4.27±0.03
	L_4XS_2	158.3±9.17	166.0±2.5	59.3±0.9	64.8±0.5	10.824±0.14	45.380±0.11	4 20±0.1
Overall mean		159.6±1.06	155.2±4.0	55.4±1.4	65.1±0.7	9.974±0.13	44.182±0.24	4.50±0.1

[a-d]: **Means for each factor within each column having similar letter(s) are not significantly different at P≤ 0.05.**

Significant (P≤0.01) supplementary light intensity level by sex ratio interactions were observed only for total number of eggs produced per duck, laying rate %, egg mass and feed conversion ratio. These clearly showed the highest egg production and the best feed conversion for ducks kept under supplementary light intensity of 10-lux and 6:1 sex ratio (Table 2).

Fertility and hatchability of eggs:

The means of eggs fertility percentage obtained for eggs produced by ducks exposed to supplementary light intensities of 10, 45 and 90 lux were nearly similar and all were significantly (P≤ 0.01) better than that obtained by the control group (1.5 lux) by 7.0, 6.2 and 6.0%, respectively (Table 3). Similar trend of response was observed in hatchability percentage of fertile eggs; where the corresponding increases (P≤ 0.01) were 13.6, 11.3 and 12.4%, respectively, as compared to the control group (Table 3).

Irrespective of the supplementary light intensity level, eggs fertility and hatchability percentages were significantly (P≤ 0.05) improved by 2.1 and 1.8% respectively, when the sex ratio was widened from 4:1 to 6:1 (Table 3).

Interactions between the effect of supplementary light intensity level and sex ratio were not significant for percentages of fertility and hatchability of fertile eggs (Table 3).

Morphological response of the reproductive organs:

The supplementary light intensity level had no significant effects on either absolute and relative weights of testes, ovary and oviduct or the oviduct length of ducks at the end of the experiment (60 weeks of age). It was observed, however, that the group of ducks subjected to a supplementary light intensity level of 10 lux had slightly higher values for these traits than the other groups, except for the oviduct length.

In this regard sex ratio had no significant effects on the morphological measurements of repeoductive organs, except for the absolute and relative weights of the oviduct which were significantly higher for ducks kept under the 6:1 sex ratio compared with those of ducks kept under the 4:1 sex ratio by 50.3 and 60.0%, respectively (Table 4).

The interactions between the effect of supplementary light intensity level and sex ratio on absolute and relative weights of testes, ovary and oviduct as well as oviduct length were not significant (Table 4).

Table (3): Effects of supplementary light intensity level and sex ratio on fertility and hatchability percentage of eggs produced by Domyati ducks

Treatments		Fertility%	Hatchability%
Light intensity level (lux); L	L_1 (1.5)	88.9±0.8^b	75.1±0.9^b
	L_2 (10)	95.1±0.4^a	85.3±0.9^a
	L_3 (45)	94.4±0.7^a	83.6±0.8^a
	L_4 (90)	94.2±0.5^a	84.4±0.9^a
Sex ratio (females:male);S	S_1 (4:1)	92.2±0.5^b	81.3±0.8^b
	S_2 (6:1)	94.1±0.5^a	82.8±0.7^a
Interaction; LXS	L_1XS_1	88.1±1.2	73 8±1 3
	L_1XS_2	89.7±1.0	76.4±1.2
	L_2XS_1	93.3±0.8	84 6±1.4
	L_2XS_2	95.2±0.7	86.0±1.1
	L_3XS_1	92.5±1.0	83.1±1.0
	L_3XS_2	96.3±0.7	84.1±1.2
	L_4XS_1	94.8±0.5	83.8±1.2
	L_4XS_2	95.4±0.7	84.9±1.2
Overall mean		93.1±4.3	82.1±4.9

a-b Means for each factor within each column having similar letter(s) are not significantly different at P≤ 0.05.

Table (4): Effects of supplementary light intensity level and sex ratio on certain morphological measurements of the reproductive organs of male and female Domyati ducks at 60 weeks of age

Treatments		Testicular weight		Ovarian weight		Oviduct weight		Oviduct length (cm)
		g	%	g	%	g	%	
Light intensity level (Lux);L	L_1 (1.5)	64.4±5.6	4.3±0.3	28.4±7.5	1.8±0.4	37.5±9.2	2.3±0.5	39.3±8 7
	L_2 (10)	79.0±1.4	4.7±0.3	48.0±5.0	3.2±0.3	60.4±8.2	4 1±0.6	49 7±2 8
	L_3 (45)	68.0±4.2	4.5±0.2	42.7±5.5	3.1±0.4	49.9±10.4	3 6±0.7	44.2±3 5
	L_4 (90)	64.7±4.5	3.7±0.1	35.1±3.9	2.6±0 3	42.3±8.3	3.1±0.6	50.8±3.6
Sex ratio; S (females: drake)	S_1 (4:1)	65.9±4.0	4.3±0.2	37.3±5.3	2.5±0.4	38.0±6.2^b	2.5±0.4^b	43.0±4.8
	S_2 (6:1)	72.2±2.3	4.3±0.2	39.8±3.1	2.8±0.21	57.1±5.8^a	4.0±0.4^a	49.0±1.9
Interaction; LXS	L_1XS_1	55.0±8.1	3.9±0.5	24.4±14.6	1.4±0.8	30.2±8.9	1.7±1.0	28.0±14.7
	L_1XS_2	73.7±2.3	4.7±0.2	12.8±7.4	2.2±0.4	44.9±3.5	2.9±0.2	50.7±6.1
	L_2XS_1	78.2±0.9	5.0±0.2	46.3±9.9	3.0±0.6	56.1±9.2	3.7±0.7	48.7±5.4
	L_2XS_2	79.7±2.8	4.3±0.5	49.8±5.1	3.4±0.4	64.8±5.1	4.4±1.1	50.7±2 8
	L_3XS_1	66.0±9.2	4.4±0.5	45.7±10.9	3.3±0.8	32.9±8 7	2.4±0 6	45 0±7 5
	L_3XS_2	70.0±0.8	4.6±0.2	39.7±5.0	2.9±0.4	67.0±3.1	4.8±0.9	43.3±2.2
	L_4XS_1	64.3±7.7	3.6±0.1	32.7±6.4	2.2±0.5	32.9±1.0	2.2±0.7	50.3±7.2
	L_4XS_2	65.2±6.6	3.8±0.3	37.5±5.6	2.9±0.4	51.6±2.6	3.9±0.9	51.3±3.5
Overall mean		69.0±10.0	4.3±0.6	38.5±15.1	2.7±0.9	47.5±2.1	3.3±1.4	46.0±12.5

a-b: Means for each factor within each column having similar letter(s) are not significantly different at P≤ 0.05.

Egg quality traits:

Eggs produced by the ducks exposed to supplementary light intensities of 10, 45 and 90 lux had significantly (P≤ 0.05) higher means of shell weight than those of the control (1.5 lux). However, egg, yolk and albumen weights, shell thickness and egg shape index were not significantly affected by supplementary light intensity level (Table 5).

Apart from the effect of supplementary light intensity level, it was observed that all egg quality traits were not affected by sex ratio (Table 5). The effects of supplementary light intensity level and sex ratio on egg quality traits were not interrelated (Table 5).

Blood plasma constituents:

Supplementary light intensity level had significant (P≤ 0.05) effects on plasma total protein and globulin concentrations of 40-week-old drakes; where the control group exhibited higher values than those of the other groups. However, plasma concentrations of albumin and albumin/globulin ratio were not significantly changed in these 40-week-old drakes in response to the varying supplementary light intensity levels. On the other hand, in the 40-week-old female ducks, supplementary light intensity level did not significantly affect plasma concentrations of total protein, albumin and globulin or albumin/globulin ratio. However, it was observed that albumin/globulin ratio was gradually decreased in these 40-week-old duck hens with elevating the intensity of supplementary light from 1.5 up to 90 lux (Table 6).

Table (5): Effects of supplementary light intensity level and sex ratio on egg quality parameters of Domyati ducks

Treatments		Egg quality parameters					
		Egg Weight (g)	Shell weight (g)	Albumen weight (g)	Yolk weight (g)	Shell thickness (mm)	Egg shape index
Light intensity level (lux); L	L_1 (1.5)	66.3±1.1	7.6±0.1[b]	36.9±0.7	21.78±0.5	0.321±0.010	0.775±0 001
	L_2 (10)	67.9±0.8	8.2±0.1[a]	37 6±0.4	22.21±0.6	0.381±0.003	0.779±0 010
	L_3 (45)	67.9±1.1	8.1±0.1[a]	37.2±0.7	22.62±0.6	0.322±0.003	0 773±0 003
	L_4 (90)	66.1±1.0	7.9±0.1[a]	36.3±0.6	22.02±0.5	0.330±0.003	0.783±0 004
Sex ratio (females:male);S	S_1 (4.1)	66.9±0.7	7.9±0.1	37.0±0.5	22.08±0.4	0.353±0.030	0.781±0.004
	S_2 (6:1)	67.2±0.7	7.9±0.1	37.0±0.4	22.23±0.4	0.329±0.002	0.774±0.003
Interaction; LXS	L_1XS_1	66.4±1.6	7.6±0.2	37.3±1.1	21.50±0.6	0.435±0.11	0.774±0.01
	L_1XS_2	66.2±1.7	7.6±0.1	36.5±0.9	22.06±0.8	0 326±0.004	0.776±0.01
	L_2XS_1	68.0±1.0	8.0±0.2	38.2±0.6	21.90±0.8	0.330±0.004	0.778±0.01
	L_2XS_2	67.8±1.2	8.4±0.1	36.9±0.6	22.53±0.5	0.331±0.004	0.779±0.01
	L_3XS_1	67.6±1.7	8.0±0.1	36.8±0.9	22.88±0.9	0.320±0.004	0.783±0.004
	L_3XS_2	68.1±1.5	8.1±0.2	37.7±1.0	22.36±0.8	0.324±0.004	0.763±0.003
	L_4XS_1	65.7±1.5	7.9±0.2	38.5±0.9	22.05±0.8	0 326±0.004	0.789±0 01
	L_4XS_2	66.6±1.4	7.7±0.2	36.9±0.9	21.98±0.8	0.334±0 01	0 778±0 01
Overall mean		67.1±2.6	7.9±0.5	37.0±1.9	22.16±1.1	0.341±0.139	0.777±0 02

[a-b] **Means for each factor within each column having similar letter(s) are not significantly different at P≤ 0.05.**

Table (6): Effects of supplementary light intensity level and sex ratio on some blood constituents of male and female Domyati ducks at 40 weeks of age

Treatments		Blood plasma constituents at 40 weeks							
		Males				Females			
		Total protein g/100ml	Albumin; A g/100ml	Globulin; G g/100ml	A/G ratio	Total protein g/100ml	Albumin; A g/100ml	Globulin; G g/100ml	A/G ratio
Light intensity level (Lux);L	L_1 (1.5)	5.37±0.1^{a}	2.82±0.1	2.55±0.3^{a}	1.20±0.2	5.30±0.3	3.20±0.21	2.07±0.1	1.58±0.1
	L_2 (10)	5.27±0.2^{ab}	2.77±0.2	2.50±0.1^{ab}	1.11±0.07	5.30±0.3	2.94±0.2	2.33±0.3	1.34±0.16
	L_3 (45)	4.63±0.1^{bc}	2.88±0.2	1.75±0.1^{c}	1.68±0.13	5.02±0.3	2.78±0.2	2.23±0.1	1.27±0.14
	L_4 (90)	4.48±0.2^{c}	2.58±0.2	1.90±0.2^{bc}	1.49±0.3	5.24±0.3	2.72±0.2	2.52±0.1	1.08±0.09
Sex ratio; S (females: drake)	S_1 (4:1)	4.96±0.2	2.78±0.1	2.18±0.2	1.36±0.12	5.33±0.2	2.98±0.2	2.34±0.1	1.33±0.11
	S_2 (6:1)	4.92±0.1	2.74±0.1	2.18±0.2	1.38±0.2	5.07±0.14	2.83±0.1	2.23±0.1	1.30±0.09
Interaction; LXS	L_1XS_1	5.43±0.6	2.90±0.06	2.53±0.5	1.29±0.4	5.40±0.5	3.33±0.3	2.07±0.3	1.49±0.2
	L_1XS_2	5.30±0.2	2.73±0.2	2.57±0.3	1.11±0.2	5.10±0.1	3.07±0.09	2.07±0.1	1.49±0.1
	L_2XS_1	5.50±0.3	2.93±0.3	2.57±0.1	1.15±0.2	5.37±0.5	2.70±0.3	2.67±0.5	1.07±0.2
	L_2XS_2	5.03±0.3	2.60±0.2	2.43±0.1	1.07±0.04	5.17±0.4	3.17±0.2	2.00±0.2	1.60±0.1
	L_3XS_1	4.53±0.4	2.87±0.3	1.67±0.1	1.72±0.2	5.13±0.4	3.03±0.4	2.10±0.2	1.46±0.2
	L_3XS_2	4.7[illegible]±0.2	2.90±0.1	1.83±0.2	1.64±0.3	4.90±0.4	2.53±0.2	2.37±0.2	1.08±0.1
	L_4XS_1	4.37±0.2	2.43±0.2	1.93±0.2	1.29±0.2	5.40±0.5	2.87±0.4	2.53±0.2	1.12±0.1
	L_4XS_2	4.60±0.3	2.73±0.2	1.87±0.4	1.70±0.5	5.07±0.2	2.57±0.3	2.50±0.1	1.04±0.2
Overall mean		4.94±0.55	2.76±0.38	2.18±0.2	1.37±0.2	5.22±0.5	2.91±0.5	2.29±0.4	1.32±0.2

a-c: Means for each factor within each column having similar letter(s) are not significantly different at $P \leq 0.05$.

At 60 weeks of age, it was observed that supplementary light intensity level had no significant effects on the studied plasma traits of Domyati drakes. But at the same age (60 weeks of age) the supplementary light intensity level had significant ($P \leq 0.01$) effects on plasma total protein and globulin concentrations of female Domyati ducks; where the control group had higher values than those kept under supplementary light intensity of 10, 45 and 90 lux. On the other hand, the concentrations of plasma albumin and albumin/globulin ratio in these 60-week-old duck hens were not significantly affected by supplementary light intensity level (Table 7).

It is worthy noting that sex ratio under which the ducks were kept (4:1 or 6:1) had no significant effects on the concentrations of plasma total protein, albumin and globulin, or on A/G ratio either at 40 or 60 weeks of age (Tables 6 and 7).

The effects of supplementary light treatment × sex ratio interactions on all studied plasma traits in males and females at both ages were not significant (Tables 6 and 7).

Blood plasma LH and FSH:

Concentrations of LH and FSH in blood plasma of male and female Domyati ducks were not significantly affected by supplementary light intensity level at 40 and 60 weeks of age (Table 8). Concentrations of LH and FSH in blood plasma of drakes (at 40 and 60 weeks of age) were slightly modified in response to increasing supplementary light intensity level without any constant trend. In females, concentrations of blood plasma LH and FSH (at 40 and 60 weeks of age) were slightly increased with increasing the supplementary light intensity level.

Table (7): Effects of supplementary light intensity level and sex ratio on some blood constituents of male and female Domyati ducks at 60 weeks of age

Treatments		Blood plasma constituents at 60 weeks							
		Males				Females			
		Total protein g/100ml	Albumin; A g/100ml	Globulin; G g/100ml	A/G ratio	Total protein g/100ml	Albumin; A g/100ml	Globulin; G g/100ml	A/G ratio
Light intensity level (Lux);L	L_1 (1.5)	4.6±0.2	2.8±0.1	1.8±0.3	1.7±0.2	5.7±0.1[a]	2.9±0.1	2.9±0.1[a]	1.0±0.04
	L_2 (10)	4.4±0.2	2.6±0.2	1.8±0.2	1.48±0.2	4.7±0.2[b]	2.6±0.1	2.0±0.2[b]	1.33±0.12
	L_3 (45)	3 9±0.1	2.3±0.2	1.6±0.1	1.52±0.2	4.9±0.2[b]	2.6±0 1	2.3±0 2[b]	1.17±0 12
	L_4 (90)	4.02±0.2	2.35±0.1	1.67±0.1	1.46±0.13	4 8±0 2[b]	2.6±0.1	2.1±0.2[b]	1.32±0 18
Sex ratio; S (females: drake)	S_1 (4 1)	4.2±0.2	2.5±0.1	1.8±0.1	1.48±0.2	5.0±0.2	2.7±0 1	2.3±0 2	1.25±0.1
	S_2 (6 1)	4.2±0.1	2.6±0.1	1.7±0.1	1.6±0.1	5.0±0.2	2.7±0.1	2.3±0.1	1.17±0.1
Interaction; LXS	L_1XS_1	4.5±0.4	2.8±0.1	1.7±0.5	1.86±0.5	5.7±0.2	2.9±0.1	2.8±0.2	1.04±0.07
	L_1XS_2	4.7±0.3	2.8±0.1	1.9±0.3	1.54±0.3	5.7±0.1	2.8±0.1	2.9±0.1	0.98±0.03
	L_2XS_1	4.4±0.5	2.4±0.4	2.0±0.3	1.31±0.4	4.7±0.3	2.5±0.2	2.2±0.2	1.19±0.1
	L_2XS_2	4.4±0.2	2.7±0.2	1.7±0.2	1.66±0.2	4.6±0.2	2.7±0.1	1.9±0 2	1.48±0 2
	L_3XS_1	3.9±0.1	2.2±0.1	1.7±0.1	1.34±0.2	4.9±0.3	2.7±0.1	2.2±0.3	1.25±0 2
	L_3XS_2	3.9±0.2	2.4±0 3	1.5±0.1	1.7±0.3	4.9±0 3	2.5±0 0	2.4±0.3	1 096±0.2
	L_4XS_1	4.1±0.4	2.4±0.1	1.7±0.2	1.41±0.1	4.7±0.3	2.7±0.1	2.0±0.3	1.5±0 3
	L_4XS_2	3.9±0.1	2.3±0.1	1.6±0.2	1.5±0.3	4.8±0.2	2.5±0.2	2.3±0 3	1.13±0 2
Overall mean		4.2±0.5	2.5±0.4	1.7±0.5	1.54±0.5	5.0±0.4	2.7±0.2	2.3±0.4	1.21±0 1

[a-b]: Means for each factor within each column having similar letter(s) are not significantly different at $P \leq 0.05$.

The sex ratio had no significant effect on LH and FSH concentrations in blood plasma of male and female Domyati ducks at 40 or 60 weeks of age (Table 8).

Table (8): Effects of supplementary light intensity level and sex ratio on plasma concentrations of LH and FSH (ng/ml) of male and female Domyati ducks at 40 and 60 weeks of age

Treatments		Blood plasma constituents							
		At 40 weeks				At 60weeks			
		Males		Females		Males		Females	
		LH	FSH	LH	FSH	LH	FSH	LH	FSH
Light intensity level (Lux);L	L_1 (1.5)	1.15±0.3	4.02±0.6	1.43±0.1	2.78±0.5	0.53±0.13	3 45±0.2	1.56±0.2	3 50±0.4
	L_2 (10)	1.61±0.4	3.08±0.8	1.83±0.2	3.81±0.5	0.34±0.10	3.82±0.6	1.66±0.1	4.20±1.4
	L_3 (45)	1.52±0.5	3 41±0.4	1.70±0.1	3.51±0.3	0.51±0.13	2.44±0.4	1.72±0.2	4.20±0.3
	L_4 (90)	0.69±0.2	2.48±0.5	1.77±0.2	3.15±0.6	0.77±0.30	2.83±0.4	1.80±0.2	3.66±0.3
Sex ratio; S (females: drake)	S_1 (4:1)	1.05±0.3	3.50±0.3	1.80±0.1	2.50±0.2	0.54±0.13	3.01±0.3	1.60±0.1	3.84±0.6
	S_2 (6:1)	1.44±0.3	3.02±0.4	1.60±0.2	3.60±0.3	0.55±0.12	2.76±0.3	1.70±0.2	3.60±0.7
Interaction; LXS	L_1XS_1	1.43±0.7	3.04±0.7	2.28±0.2	3.31±0.8	0.71±0.02	3.45±0.2	1.45±0.1	3.33±0.6
	L_1XS_2	0.87±0.1	5.0±0.8	1.38±0.04	4.31±0.5	0.34±0.10	3.46±0.5	1.68±0.4	3 57±0 7
	L_2XS_1	1.44±0.8	3.40±0.9	1.61±0.2	1.90±0.2	0.34±0.04	2.5±0 9	1.63±0.1	2 48±0.4
	L_2XS_2	1.78±0.2	2.75±0.5	1.24±0.1	3.70±0.7	0.35±0.20	3.13±0.8	1.28±0.1	5.88±2.5
	L_3XS_1	0.67±0.3	4.10±0.5	1.62±0.2	2.30±0.3	0.48±0.20	2.60±0.4	1.77±0.4	6.40±1.7
	L_3XS_2	2.38±0.7	2.71±0.4	1.78±0.1	2.7±0.4	0.54±0.20	2.27±0.8	1.67±0.1	1.95±0.3
	L_4XS_1	0.65±0.3	3.32±0.8	1.53±0.2	2.5±0.1	0.57±0.40	3.49±0.6	1.49±0.1	3.18±0.5
	L_4XS_2	0.74±0.3	1.64±0.2	2.01±0.2	3.80±1.1	0.97±0.40	2.16±0.3	2.11±0.3	2.94±0.3
Overall mean		1.24±0.9	3.20±1.1	1.68±0.24	3.06±1.0	0.54±0.90	2.89±1.1	1.64±0.43	3.70±0.5

No significant effects of supplementary light treatment × sex ratio interactions were observed on plasma FSH and LH concentrations in male and female ducks at 40 and 60 weeks of age (Table 8).

Economic efficiency (%):

Table 9 illustrates items involved in calculating the economic efficincy (EE) of producing settable eggs (*i.e.* ducklings production) under the four supplementary light intensity levels and the two sex ratios applied in this study. General speaking, the calculated values of EE for the experimental groups of Domyati ducks subjected to the higher levels of supplementary light intensity (10, 45 and 90 lux) were considerably higher than that of the control group (1.5 lux), with the highest EE value recorded for those exposed to 10 lux. This was mainly attributed to higher egg production (Table 2) and higher eggs hatchability percentage (Table 3) of these duck groups as compared to the control group. Higher EE value was also recorded with the 6:1 than with the 4:1 sex ratio.

Table (9): Effects of supplementary light intensity level and sex ratio on economic efficiency of egg production and incubation of eggs produced by Domyati ducks from 20 to 60 weeks of age

Treatments		Cost			Total eggs produced by duck	Cost/egg produced (L.E)	Total hatched ducklings	Total income (L.E)	Net return (L.E)	EE%
		Electricity per duck (L.E)	Feed per duck (L.E)	Total (L.E)						
Light intensity level (lux); L	L_1 (1.5)	0.06	45.6	45 66	119	0 38	79.5	79.5	33 8	74 0
	L_2 (10)	0.24	49.90	50.14	173	0.29	139.0	139 0	88.9	177 3
	L_3 (45)	0.59	49.5	50.09	165	0.30	130.2	130.2	80 1	159.9
	L_4 (90)	1.17	49.4	50.57	163.8	0.31	131.4	131.4	80.8	159.8
Sex ratio (females:male);S	S_1 (4:1)	0.515	48.4	48.56	147.4	0.33	110.5	110.5	61 9	127 5
	S_2 (6:1)	0.515	49.16	49.68	163.0	0.31	127.0	127.0	77.3	155.6

DISCUSSION

The study of light intensity or sex ratio in the fowl is complicated by the interactions of numerous factors which may hinder straightforward explanations. There is, however, a voluminous literature on the use of light intensity and sex ratio in poultry production; as a husbandry procedure, to improve the productive and reproductive performance. In this connection, little research has been carried out on ducks. Therefore, due to the fact of existing genotypic differences in the response of the different poultry genera to such procedures, the comparison between the current results and those of other investigators may sometimes lose its validity.

Concerning the effects of supplementary light intensity level, the present results showed that groups of Domyati ducks exposed to supplementary light intensity levels of 10, 45 and 90 lux reached the age at sexual maturity earlier than the control group (1.5 lux) by 5 days, but with no significant differences (Table 2). In line with this result, light intensities below 4 lux have been reported to delay sexual maturation of caged pullets (Wilson *et al.*, 1956). About one-week delay in sexual maturation was reported by Dorminey *et al.* (1970) for pullets reared under 1.1 lux compared to pullets reared under 3.2, 5.4, 10.8, or 32.3 lux. In turkey hens, however, Vehse and Ellendorff (2001) found that a light intensity of approximately 20 lux is required for reaching early sexual maturity. Recently, Lewis *et al.* (2004) found no significant difference in sexual maturity, in ISA Brown pullets maintained under 3 or 25 lux but there was a significant delay in sexual maturity of Shaver White pullets exposed to 3 lux compared with those maintained under 25 lux.

The present results showed that 10 lux was the appropriate supplementary light intensity level for Domyati ducks to attain the best laying performance in terms of laying rate%, egg weight and egg mass (Table 2). The present results indicated also that supplementary light intensity levels of 45 and 90 lux had a similar photo-induction of egg production parameters of ducks, but they gave higher laying performance than that occurred with the 1.5 lux (control). In agreement with the obtained results, earlier reports (Morris and Owen, 1966) indicated that a minimum light intensity level of 10 lux was needed to support normal egg production of laying fowls, but the higher levels had no effect on laying performance. Also, Lewis and Morris (1999) showed that the rate of lay exhibits a curvilinear response to illuminance and that the light intensity level of 5 lux probably gives the optimal balance between lighting cost and egg income, but light intensity of 10 lux is still a sensible level to be recommended for laying houses.

The magnitude of response of laying poultry to light intensity depends on a number of factors such as species and strain (Nestor and Brown, 1972), environmental factors, especially daylight (Meyer *et al.*, 1988) as well as season and type of confinement (Siopes, 1991). According to the literature, a wide range of light intensity level can affect egg production of domestic poultry. Controversially with the present results, Davis *et al.* (1993) reported that breeder Pekin ducks exhibited a greater egg production when they were exposed to intensity level of 172 lux of high-pressure sodium light compared to that of ducks subjected to 10 lux of incandescent light. In turkeys, an increase in egg production was reported when light intensity increased from 18 to 51 lux (Nestor and Brown, 1972). In addition, light intensities of 53.8 and 166.4 lux appeared to be equally effective in stimulating egg production of turkey hens (Hulet *et al.*, 1992). In chickens, similar results were obtained with light intensities ranging from 2 lux (Morris, 1967) to 800 lux (Brake and Baughman, 1989). In a study with two lines of geese, Pyrzak *et al.* (1984) observed a significant increase in egg production under 20 lux as compared with that obtained under 50 lux, and they speculated that such effect on egg production was probably due to an interaction of light source, light intensity and the genetic make-up of geese strain.

It is of interest to note that, in the present study, Domyati ducks exposed to supplementary light intensity of 10 lux consumed the greatest amount of feed and exhibited the best feed conversion (Table 2). The improved feed conversion achieved by this experimental group of Domyati ducks may be attributed to its superiority in laying rate, egg weight and egg mass. In accordance with the present results, Dorminey *et al.* (1970) reported that layers subjected to light intensity of 10.8 lux exhibited an improved feed conversion compared with their counterparts kept under 32.3 lux. In a study with turkey toms exposed to light intensity from 10 to 700 lux, Yahav *et al.* (2000) indicated that the lowest light intensity may cause a reduction in food intake and in turn feed conversion efficiency is improved, and they concluded that this likely to be related to differential investment of energy expenditure for maintenance. The energy expenditure of poultry is affected by physical activity and a number of endogenous and environmental factors (Balnave, 1974; Squibb, 1975 and Van Kampen, 1976). Boshouwers and Nicaise (1987) examined the effect of light intensity on the energy expenditure of laying hens and found that a decrease in light intensity from 120 to 1 lux reduced total energy expenditure by 18%. Low light intensity was found to reduce both heat production and core body temperature, probably due to a reduction in physical activity (Li *et al* ., 1992). Physical activity was found to be almost zero in the dark and positively correlated with light intensity (Boshouwers and Nicaise, 1987).

In the present study, no further improvement was achieved in eggs fertility and hatchability when the ducks were exposed to light intensity levels beyond 10 lux (Table 3). It can be suggested that, part of this improvement in egg fertility may be related to a better gonadal development or activity under this level of supplementary light intensity (10 lux). In contrast with the present results, Davis *et al.* (1993) reported that eggs fertility of breeder Pekin ducks was significantly higher under light intensity of 172 lux than under 10 lux. However, it is uncertain whether the improvement of egg fertility; under the different supplementary light intensity levels of 10, 45 or 90 lux in comparison with that of the control (1.5 lux) of the present study, was due to the reproductive status of the duck hen or drake. In another study, Tag El-Din *et al.* (2006) reported that the exposure of Domyati ducks to increasing supplementary light intensity levels (1.5, 10, 45 and 90 lux) significantly improved the semen quality in drakes. However, part of the improvement in eggs fertility can be attributed to the beneficial effect of increasing the supplementary light intensity level to 10 to 90 lux on the morphological status of the reproductive system of duck hens (Table 4).

In the present study there was a marked tendency of a heavier testicular weight in drakes subjected to the supplementary light intensity of 10 lux as compared to those exposed to the other supplementary light intensity levels (Table 4). There are no available data concerning the effect of light intensity on the morphology of the reproductive system in ducks. In male turkeys subjected to light intensity from 10 to 700 lux, Yahav *et al.* (2000) found that concentration of plasma T3 was significantly greater under light intensity of 10 lux, but testicular weight was not affected. However, it is well documented that thyroid hormones are involved in the development of the reproductive system (Cooke, 1996). Also, Jones *et al.* (1977) and Leighton and Jones (1984) found that semen quality was improved in turkey toms exposed to light intensities of 43 lux or greater. The obtained results indicated that female ducks exposed to a supplementary light intensity of 10 lux tended to have a higher ovarian weight as compared to those subjected to the other supplementary light intensities (Table 4). In line with the present result, Renema and Robinson (2001) found that laying hens exposed to a light intensity of one lux had lighter ovaries and fewer large yellow follicles than did those subjected to other three light intensity levels (5, 50 or 500 lux), and they concluded that the threshold light intensity for a complete ovary morphological response to photostimulation was 5 lux. On the other hand, Morris (1967) stated that maximum stimulus of the photoperiodic mechanism has been proposed for light intensity above 5 lux, with decreasing stimulation as light intensity is reduced.

The obtained results revealed that the exposure of experimental ducks to a supplementary light intensity of 10 lux was associated with production of eggs having thicker shells (Table 5). In this respect, 10 lux of incandescent or 172 lux of high-pressure sodium light did not consistently affect egg quality parameters in breeder Pekin ducks (Davis *et al.*, 1993). On the other hand, in a study conducted on laying hens subjected tc different light intensities of 1, 5, 50 or 500 lux, Renema *et al.* (2001) found that laying hens exposed to a light intensity level of 500 lux produced eggs of lower weight in combination with reduced shell quality, and concluded that inadequate feed intake under this high light intensity condition (500 lux) may be a contributing factor involved in such adverse effect.

An inconsistent trend of change was observed in concentration of total protein and its fractions in blood plasma in males and females either at 40 or 60 weeks of age (Tables 6 and 7). The observed general trend was an increased concentration of total protein with supplementary light intensity of 1.5 lux as compared to the higher intensity levels. Such increase was almost associated with increase in globulin concentration rather than albumin.

In males, the secretion of LH controls the production of the major sex steroid (testosterone) secreted by Leydig cells in the testes (Bacon *et al.*, 1980). Even though, supplementary light intensity levels (1.5, 10, 45 and 90 lux), applied herein, did not significantly affect blood plasma concentrations of LH and FSH in Domyati drakes at 40 or 60 weeks of age (Table 8), under these supplementary light intensities it was reported that the semen quality was improved in Domyati drakes with increasing the supplementary light intensity level (Tag El-Din *et al.*, 2006). In females, the secretion of LH and FSH controls the secretion of estrogen, necessary for yolk precursor lipoprotein synthesis and secretion by the liver (Bacon *et al.*, 1980), and, oviduct and ovarian follicles development. The obtained results indicated a tendency of an insignificant increase in LH concentration by increasing the supplementary light intensity level above 1.5 lux at 40 and 60 weeks of age (Table 8). In agreement with this finding, Lewis *et al.* (2004) found that plasma LH concentration in Shaver White and ISA Brown pullets kept under a light intensity of 3 lux was lower than that of pullets exposed to 25 lux. Hormones such as FSH, change with photo-stimulation and may be important in controlling estradiol secretion (Gooden and Scanes, 1977). In the present study, the exposure of ducks to supplementary light intensity levels above 1.5 lux resulted in an insignificant increase and no clear-cut trend of FSH concentration in female and male ducks respectively (Table 8).

Regarding the effects of sex ratio, the present results indicated that ducks with the sex ratio of 6:1 (females to male) attained higher feed intake, egg production and egg mass and better feed conversion than did those with the sex ratio of 4:1 (Table 2). However, Davis *et al.* (1993) found no significant differences in hen-day egg production of breeder Pekin ducks maintained under two sex ratios; 22 hens:4 drakes (15% males) and 21 hens 5 drakes (19% males). In the present study, fertility rate and hatchability of eggs produced by the experimental ducks were significantly improved with the sex ratio of 6:1 compared with those of the 4:1 sex ratio (Table 3). Inconsistently with the present result, Aggarwal and Dipankar (1986) kept Pekin ducks under 3 sex ratios (5:1, 10:1 and 15:1; females to male) and found that eggs fertility percentages were significantly higher with the sex ratios of 10:1 and 15:1 compared to that obtained with the sex ratio of 5:1. However, Davis *et al.* (1993) reported that a breeder Pekin duck flock with a sex ratio of 22:4 hens to drakes (15% males) was adequate to achieve optimum eggs fertility similar to that attained with a sex ratio of 21:5 hens to drakes (19% males)

Egg quality parameters of Domyati ducks were not affected significantly by sex ratios used in this study (Table 5). In line with the present result, Davis *et al.* (1993) found that sex ratios of 21:5 or 22:4 females to males did not consistently affect egg quality parameters (in terms of egg weight, shell weight and shell thickness) during the egg production cycle of breeder Pekin ducks.

From an economic point of view, it is well documented that, in addition to reproductive performance, energy utilization in the form of electricity and feeding cost are a major concern in poultry breeder management. Certainly, any power used in lighting above that allows a maximum response is a wasted energy and an economic loss (Siopes, 1991). On the other hand, drakes are more expensive to raise and maintain due to their feed consumption, and reproductively active drakes tend to be very aggressive as a breeder that can injure or even kill hens (Davis *et al.*, 1993). In the current study, the highest (177.3%) economic efficiency (EE) was achieved by ducks exposed to the supplementary light intensity level of 10 lux, as compared to EE values of 74.0, 159.9 and 159.8% attained by ducks subjected to supplementary light intensities of 1.5, 45. and 90 lux, respectively (Table 9). As for the effect of sex ratio, a higher EE (155.6%) was obtained with the sex ratio of 6:1 compared with that (127.5%) achieved with the 4:1 sex ratio (Table 9). This result showed that exposure of the experimental ducks; with 6:1 sex ratio, to the supplementary light intensity level of 10 lux had an economic advantage over the other treatments.

Conclusion

The use of a 10-lux artificial light in supplementing the natural daylight to achieve a daily photoperiod of 17 hours in combination with a sex ratio of 6:1 (duck hens to drake) for breeder Domyati ducks during the laying season is economic and adequate to achieve a satisfactory productive and reproductive performance.

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تأثيرإطالة ضوء النهار بمستويات مختلفة من الضوء الصناعي و النسبة الجنسية على الأداء الإنتاجي و التناسلي للبط الدمياطي.

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**معهد بحوث الإنتاج الحيواني- وزارة الزراعة – الجيزة

أجريت هذه الدراسة لتقييم تأثير مستويات مختلفة من الإضاءة الإضافية مع النسبة الجنسية على الأداء الإنتاجي و التناسلي للبط الدمياطي. استخدم ٥٥٢ طائر بط دمياطي عمر ١٨ أسبوعا (٤٥٦ أنثى +٩٦ ذكر) تم توزيعها عشوائيا على ٨ مجموعات بكل منها ثلاث مكررات وكانت النسبة الجنسية في المجموعات الأربعة الأولي ٦ إناث لكل ذكر بينما في الأربع مجموعات الأخرى كانت النسبة الجنسية ٤ إناث لكل ذكر. تم تربية الطيور في عنابر أرضية منفصلة و عرضت لفترة إضاءة قدرها ١٧ ساعة يوميا حتى نهاية التجربة في عمر ٦٠ أسبوعا. و لتحقيق هذه الفترة الضوئية خلال فترة التجربة (من ٢٠-٦٠ أسبوعا) تم إطالة ضوء النهار الطبيعي (ساعة قبل الشروق والباقي بعد الغروب) باستخدام ضوء صناعي بشدة إضاءة ١,٥ لوكس (مجموعة المقارنة) أو ١٠ أو ٤٥ أو ٩٠ لوكس عند مستوى رأس الطائر للمجاميع الأربع داخل كل نسبة جنسية على التوالي. أخذت القياسات على كل من الأداء الإنتاجي (العمر عند النضج الجنسي و عدد البيض الكلي و معدل الوضع ووزن البيضة و كتلة البيض و استهلاك الغذاء و معدل التحويل) و نسبتي الخصوبة و الفقس و بعض صفات جودة البيض (وزن البيضة ووزن القشرة ووزن الصفار ووزن البياض وسمك القشرة و دليل شكل البيضة) و كذلك بعض القياسات للأعضاء التناسلية (أوزان الخصيتين و المبيض و قناة المبيض و طول قناة المبيض) كما تم قياس تركيز بعض مكونات الدم (البروتين الكلي و الألبيومين و الجلوبيولين و هرموني LH وFSH) .

وكانت أهم النتائج المتحصل عليها كالتالي:

أثرت شدة الإضاءة الإضافية و كذلك النسبة الجنسية معنويا على كل من عدد البيض الكلي و معدل الوضع و كتلة البيض و استهلاك الغذاء و معامل التحويل بينما لم يتاثر كل من العمر عند النضج الجنسي ووزن البيضة معنويا بالمعاملات مع تميز مستوى الإضاءة الإضافية ١٠ لوكس و النسبة الجنسية ٦ : ١ عن باقي المعاملات. تحسنت نسبتي الخصوبة و الفقس معنويا عند تعريض الطيور إلى مستوى شدة إضاءة إضافية ١٠ لوكس تحت النسبة الجنسية ٦ : ١ و لم يكن هناك تحسن إضافي عندما ازداد مستوى شدة الإضاءة الإضافية إلى ٤٥ أو ٩٠ لوكس. باستثناء الارتفاع المعنوي في وزن قناة المبيض مع النسبة الجنسية ٦ :١ لم يكن لشدة الإضاءة الإضافية أو النسبة الجنسية تأثيرا معنويا على وزن الخصيتين أو المبيض أو طول قناة المبيض. لم تتأثر صفات جودة البيض معنويا بمستوى شدة الإضاءة الإضافية أو النسبة الجنسية باستثناء حدوث ارتفاع معنوي في وزن القشرة مع استخدام شدة إضاءة إضافية بمستويات ١٠ و ٤٥ و ٩٠ لوكس . كان لمستوى شدة الإضاءة الإضافية تأثيرا معنويا على كل من مستويات البروتين الكلي و الجلوبيولين في بلازما الدم لذكور البط الدمياطي عند عمر ٤٠ أسبوعا و كذلك في إناث البط عند عمر ٦٠ أسبوعا بينما لم تتاثر باقي قياسات بلازما الدم معنويا باي من المعاملات. كان تأثير التفاعل بين مستوى شدة الإضاءة الإضافية و النسبة الجنسية معنويا على كل من عدد البيض الكلي ومعدل الوضع و كتلة البيض و معدل التحويل بينما لم يكن هناك تأثيرا للتفاعل على باقي الصفات.

و من هذه الدراسة يمكن استخلاص أن استخدام إضاءة صناعية بمستوى ١٠ لوكس لإطالة ضوء النهار الطبيعي للحصول على ١٧ ساعة إضاءة يوميا مع نسبة جنسية ٦ :١ لبط التربية الدمياطي يكون كافيا من الوجهة الاقتصادية للحصول على أداء إنتاجي و تناسلي مقبول.